in this year, almost simultaneously with the works of Bischoff and Voit, appeared the first number of the *Beiträge zur Begründung einer rationellen Fütterung der Wiederkäuer*, by Henneberg and Stohmann. For the first time the solid and liquid materials excreted by herbivora under well-defined circumstances had been carefully studied in numerous experiments, with reference to quantity and chemical composition. These experiments threw much light on the food requirements of mature oxen, and showed in general the manner in which important questions in animal nutrition must be solved."

The specific questions proposed for study by Henneberg early in his work are stated by him as follows:

(1) What are the actually nutritive ingredients in different feeding stuffs and in what proportions do they occur in each?

(2) In what proportions must their nutritive ingredients be fed in order to produce from a minimum of food the maximum of flesh (lean) or fat, or both?

For the solution of these questions, Henneberg, with his assistants and colaborers at Weende, among whom have been Stohmann, Gustav Kühn, Rautenberg, Maercker, H. Schultze, E. Schulze, Fleischer, K. Müller, Kern, Wattenberg, Th. Pfeiffer, and F. Lehmann, undertook investigations upon the methods of analysis of feeding stuffs. digestibility of the ingredients, and the nutritive effects as shown by feeding experiments.

The methods of analysis of feeding stuffs known as the Weende or Henneberg-Stohmann methods, which with minor modifications are in common use in Europe and America to-day, were elaborated and soon found general recognition. These methods were applied not only to determining the percentages of cellulose, fat, protein, and nitrogen-free extract in feeding stuffs, but also in connection with feeding experiments, to determining the amount of each of these ingredients actually digested by animals. Henneberg reasoned that if the feces as well as the food given, were subjected to analysis, the difference between the amount of each ingredient in the food and in the feces would represent the amounts of crude cellulose, crude fat, crude protein, and nitrogen-free extract which had been digested, an idea which at that time (1859) was new. Experiments were begun on the digestion by cattle of various feeding stuffs when fed alone or in combination with large or small quantities of easily digestible materials, and these were after a time taken up by other experimenters. Early in these investigations it was discovered that the crude fiber of the coarser fodders (hay, straw, etc.), which up to this time had been considered as indigestible, was to a large extent (one half or more) dissolved in the intestinal canal, and that the nitrogen-free extract, which had been supposed to be wholly digested, was in the case of coarser fodders, scarcely more digestible than the crude fiber. It was found that in the process of digestion crude cellulose yields a substance having the formula of pure cellulose

or starch in solution. A third discovery was with regard to a depression in digestibility sometimes noticed.

Henneberg early reached the conclusion that "without the aid of respiration experiments the laws underlying the formation of flesh and fat can not be worked out conclusively." In 1862 means were secured from the Government of Hanover for erecting a respiration apparatus on the plan of that used by Pettenkofer in Munich in investigations on carnivorous animals. For many years this was the only apparatus of the kind in use in agricultural investigations. Unexpected and serious difficulties were met with in the use of an apparatus sufficiently large for the purpose, and years of patient labor were required to overcome these. At length, however, it became possible to present a clear and complete representation of the transformation of nitrogen within the body, and to work out the first metabolic proportions for farm animals. The results of the experiments of Pettenkofer and Voit on carnivorous animals were applied by Henneberg and his assistants to ruminants, and happily for the progress of science the results obtained in Munich and in Weende confirmed each other. The most important facts brought out for ruminants were as follows:

An increased consumption of protein in the food is accompanied by an increased breaking down of the albuminoid materials of the body, *i. e.* increased nitrogen metabolism.

The amount of protein in the food regulates the nitrogen metabolism but not the nitrogen storage, that is to say, the amount of protein transformed but not the amount of lean flesh accumulated in the body. It is a mistake, therefore, to assume that such nitrogenous feeding stuffs as bean meal or rape cake will in all cases increase the production of lean flesh or other nitrogenous materials of the body to a degree that will be pecuniarily profitable.

The addition of non-nitrogenous ingredients to the food without changing the protein may cause an increased formation of flesh (lean). These materials may, under some conditions, produce as good results as the addition of a like amount of protein to the food.

The formation of fat in the body of neat cattle probably takes place irrespective of the presence or absence of fat in the food. The exact influence of protein on the formation of fat remains to be determined,

Under otherwise corresponding circumstances, the process of respiration in different-sized animals is dependent on the surface exposed, *i. e.*, the area of the surface of the body.

In 1879, studies were begun as to the effect on the total metabolism in grown animals of adding different and increased proportions of the several ingredients of food to a maintenance ration. The first series of these experiments was with regard to the albuminoids. This was worked out according to the original plan, but could not be published until recently (see Experiment Station Record, vol. II, p. 462). Similar experiments with regard to the carbohydrates and fats were carried out in 1882, but the means for controlling the results and extending the

experiments were not at hand. Additional funds for this purpose were at length secured, and in 1889 the experiments were again taken up.

The results of 3 years of experimenting at the station leave no room for doubt that in the process of flesh formation a highly digestible cellulose is not essentially different in its action from the easily soluble carbohydrates. The results of more recent experiments, extending over a shorter period, indicate further that in the laying on of fat digestible cellulose is very little, if at all, inferior in its action to other carbohydrates.

To recapitulate, the work of the experiment station at Weende-Göttingen has been principally in three directions: First, the overthrowing of the theory of hay-values, the setting up in its place of a theory based on chemical composition, and the working out of the Weende methods of analysis. Second, the recognition of the fact that to give these analyses their full value, they must be accompanied by coefficients of digestibility based on trials with animals. The first experiments of importance in this direction were made at Weende. The digestibility was determined for numerous coarse and concentrated feeding stuffs, and the influence of concentrated feeds rich and poor in nitrogen, on the digestibility, was studied. The study of digestibility and depression in digestibility had its origin at Weende. Third, the study of the laws of flesh (lean) and fat formation in herbivora, showing these laws to be in all particulars the same as those laid down by other investigators for carnivorous animals.

The capabilities of the station as now equipped are stated by the present director, Prof. Franz Lehmann, as follows:

"We are now able by the use of an apparatus of inestimable value, to determine within a few grams the amount of fat daily stored in the body by sheep, and the storage of protein perhaps even more accurately. We are therefore in a position to take up and answer numerous questions relating to the feeding of animals."

The work of the immediate future, as outlined by him, is to be of a practical nature. Attention will be given to such questions as that of the advisability of feeding a ration richer in nitrogen than the normal ration usually accepted.

Years have been spent in preparation for the practical work which it is now proposed to undertake, and it is confidently believed by the director that investigations with the respiration apparatus will lead to methods of feeding which will render it possible to "produce at will more lean meat and less fat, and cheaper and better meat."

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama College Station, Bulletin No. 25 (New Series), April, 1891 (pp. 12).

EFFECTS ON BUTTER OF FEEDING COTTON SEED AND COTTON-SEED MEAL, N. T. LUPTON, LL. D.—To test the effects "on the volatile acids, melting point, and specific gravity of the butter produced under their influence," the following rations were fed to a herd of 11 Jersey cows in five periods of 7 days each, the periods being separated by intermediate periods of 1 week each:

Period I. 5 pounds ground oats. 5 pounds bran, 5 pounds corn meal.
Period II. 4 pounds ground oats, 5 pounds bran, 3 pounds cotton-seed meal, 11 pounds silage.
Period III. 4 pounds cotton-seed meal, 4½ pounds silage, 9 pounds cotton-seed hulls.
Period IV. Raw cotton seed and cotton-seed hulls *ad libitum.*
Period V. Cooked cotton seed and cotton-seed hulls *ad libitum.*

The analyses of the feeding stuffs used and the yield and composition of milk and butter in each period are tabulated. These data indicate "a marked falling off in the quantity of milk and an increase in the amount of butter produced during the first three periods." In the fourth and fifth periods there was a decided decrease in the amount of both milk and butter.

From the first to the fourth periods the volatile acids of the butter decreased and the melting point increased, the increase in melting point amounting to about 8° C. In the fifth period there was a slight increase in volatile acids and decrease in melting point. "No change was observable in the color of the butter from feeding cotton seed and cotton-seed meal."

Alabama College Station, Bulletin No. 26 (New Series), April, 1891 (pp. 41).

COMMERCIAL FERTILIZERS, N. T. LUPTON, LL. D.—Tabulated analyses of 343 samples of commercial fertilizers and fertilizing materials, including cotton-seed meal, cotton-seed-hull ashes, tankage, dried blood, bat manure, phosphatic rock, acid phosphate, compost, ground bone, bone ash, muriate of potash, nitrate of soda, and ashes from a coke furnace.

Alabama College Station, Bulletin No. 27 (New Series), May, 1891 (pp. 16).

BLACK RUST OF COTTON, G. F. ATKINSON, PH. B. (plates 2).—This is, in substance, a paper read before the section on botany of the Association of American Agricultural Colleges and Experiment Stations, in November, 1890, and afterwards published in the *Botanical Gazette*, vol. XVI (1891), pp. 61–65. The author calls attention to the confusion existing with reference to the name of this disease, which is not a true rust. His observations indicate that what is popularly known as "black rust of cotton" is of a complex character. "The fungi commonly present and which play an important part in the disease, are *Cercospora gossypina*, Cooke, *Colletotrichum gossypii*, E. A. Southworth, *Macrosporium nigricantium*, Atkinson, a species of *Alternaria*, and a bacterial organism which sometimes produces a characteristic disease of the leaves." The difference between leaf blight and black rust of cotton is pointed out, and the botanical characters of the fungi connected with the latter disease are described and illustrated. The author has observed on dead leaves of cotton a sphæriaceous fungus which he thinks is probably the ascospore stage of *Cercospora gossypina*. The following is taken from his description of *Macrosporium nigricantium* (see also *Botanical Gazette*, vol. (XVI 1891), p. 62):

The hyphæ are dark or olive brown and borne on both sides of the leaf. At the enlargements there is usually a darker band around the center. The hyphæ thus have a nodulose appearance, as in such species as *Macrosporium parasiticum*, Thüm. The spores are olive brown, oblong, constricted in the middle, and stoutly rostrate at one side of the apex. As the young spore develops it is constricted in the middle before the first transverse partition is formed. This is formed in the constricted portion. Later other transverse, longitudinal, and oblique septa are produced. * * * The fertile hyphæ are usually scattered, rarely in clusters of two or three. Measurements: Hyphæ are 0.050 to 0.140^{mm} long by 0.006 to 0.007^{mm} in diameter; conidia, 0.018 to 0.022^{mm} by 0.036 to 0.050^{mm}.

The *Alternaria* is illustrated from a water culture under the microscope. The fertile hyphæ produce concatenate spores. Both the spores and the fertile hyphæ are dark brown in color and when occurring in considerable numbers blacken the leaf.

The bacterial disease is often very widespread, even when no evidences of the other fungi are to be found, but is mentioned here because frequently it is an accompaniment of the black "rust" and contributes materially to the aggravation of the disease. It is first manifested by a watery appearance in definite areolate spots, which are bounded by the veinlets of the leaf. The spots are sometimes very numerous and frequently conjoined; often the disease follows one or more of the main ribs of the leaf, being bounded on each side by an irregularly zigzag line. As the disease ages, the spots become blackish and then light brown, then frequently bordered by a blackish color where the disease has extended somewhat centrifugally. The dead spots in the leaves sometimes break out, leaving many perforations in the leaves with ragged edges, somewhat as results in cotton leaf blight. The disease hastens the falling off of the leaves.

External characters and progress of the disease.—During the entire season (from July to the close of October), of the thousands of leaves, old and young, that I examined,

Cercospora gossypina has been an almost universal accompaniment, and has not been second in point of attack, except perhaps in rare cases. In many cases parallel or immediately succeeding attacks were made by the *Colletotrichum*. The *Macrosporium*, as a rule, follows closely the attack of the *Cercospora*, indeed sometimes seeming to be first to attack. In such cases possibly it attacked the spots diseased by *Cercospora* before the hyphæ and conidia of the latter were developed. The *Alternaria* usually succeeds the *Macrosporium*, though often seeming to be parallel with it. By its clusters of hyphæ and profusely developed concatenate spores in favorable weather the leaf is soon covered with a mass of spores, giving a blackened appearance to the leaves.

Current theories regarding the cause of the disease are discussed. Experiments with reference to its repression will be conducted at the station.

Colorado Station, Bulletin No. 15, April, 1891 (pp. 22).

CODLING MOTH AND GRAPEVINE LEAF HOPPER, C. P. GILLETTE, M. S. (figs. 5).—Compiled notes on the codling moth (*Carpocapsa pomonella*) and the grapevine leaf hopper (*Typhlocyba vitis*), with suggestions as to means for their repression.

Connecticut State Station, Annual Report, 1890 (pp. 207).

REPORTS OF BOARD OF CONTROL, TREASURER, AND DIRECTOR (pp. 3–8).—These include brief statements regarding the work of the station and an exhibit of receipts and expenditures for the fiscal year ending June 30, 1890. One hundred and forty-six distinct brands of fertilizers are known to be on sale in the States. The analyses of these and other manurial substances made at the station in 1890 numbered 310. Analysis fees collected during the fiscal year amounted to $4,221.50. The station has material for reports on examinations of seeds, analyses of potatoes, molasses, maple sirup, vinegar, and butter, and a coöperative experiment on the composition of corn grown in different localities, but lack of funds prevents their immediate publication.

FERTILIZERS (pp. 9–79).—Abstracts from the Connecticut fertilizer law, a list of manufacturers complying with this law, the brands of fertilizers licensed in the State during 1890, analyses of fertilizers, revised explanations concerning the analysis and valuation of fertilizing materials, the trade values of fertilizing ingredients for 1890, and a review of the fertilizer market.

Analyses of fertilizers and waste products.—Analyses are given of 314 samples of fertilizing materials, which include besides branded mixed fertilizers, nitrate of soda, sulphate of ammonia, dried blood, cotton-seed meal, castor pomace, hoof meal, Thomas slag, precipitated phosphate, dissolved boneblack, double sulphate of potash and magnesia, muriate of potash, kainit, bone manures, tankage, home-mixed fertilizers, cotton-hull ashes, unleached wood ashes, limekiln ashes, limestone, wool waste, tank water and settlings from bone and

wool-scouring works, plaster, barnyard manure, rockweed, seaweed, Iceland moss, and pigeon manure.

One sample of cotton-seed meal was found to be "adulterated with rice meal, which is harmless, but reduces the value of the meal either as a food or fertilizer, by $4 or $5 a ton. The color of the meal was rather lighter than pure meal, but the adulteration is not likely to be detected without microscopic or chemical examination."

Concerning the mixed fertilizers it is stated that "in five cases the valuation [of superphosphates] exceeded the cost. Leaving out of account three analyses in which the cost exceeded valuation by considerably more than 50 per cent, the average cost of 62 nitrogenous superphosphates was $33.80 and the average valuation $28.57. The difference is $5.23 and the percentage difference 18.3. * * *

"The average cost of 33 special manures has been $39.18 and the average valuation $32.90. The difference between the cost and valuation has been $6.28 and the percentage difference 19.

"This year the special manures as a class have been higher priced and more concentrated than the other nitrogenous superphosphates, but not, as heretofore, more economical to purchase."

Review of the fertilizer market.—A table is given with explanations, showing the fluctuations in the wholesale prices of nitrogen, potash, and phosphoric acid in a number of standard materials for each month from July, 1887, to December, 1890, and two other tables facilitating the calculation of the cost of nitrogen per pound from the cost of ammonia per unit or per pound of commercial sulphate of ammonia, as given in the market quotations.

In general, nitrogen in blood, azotin, nitrate of soda, and fish scrap have fallen decidedly in price during the year. The nitrogen of sulphate of ammonia has, on the other hand, risen considerably.

Charleston rock is considerably lower, boneblack somewhat lower; bone has remained constant through the year.

Acid phosphate made from South Carolina rock is considerably lower than at the opening of the year.

Muriate of potash, double manure salt, and kainit are quoted about as they have been through the year, but high-grade sulphate is very considerably lower.

REPORT OF MYCOLOGIST, R. THAXTER, PH. D. (pp. 80–113, plates 3, figs. 3).—*Potato scab* (pp. 81–95).—This is a detailed report of observations previously summarized in Bulletin No. 105 of the station (see Experiment Station Record, vol. II, p. 490). The substance of the present article was also presented in a paper read before the section on botany of the Association of American Agricultural Colleges and Experiment Stations, at Champaign, Illinois, November 12, 1890. The topics treated are, Theories of the Origin of Potato Scab, General Characters of the Disease and of the Scab Fungus when Cultivated, Life History of the Scab Fungus, Inoculations Made with the Scab Fungus, A Comparison of "Deep" and "Surface" Scab, and The Botanical Relations of the Scab Fungus. Specimens of potatoes affected with the ordinary deep

scab and with the same form of scab induced by inoculation are illustrated in a plate accompanying the article.

Miscellaneous notes (pp. 95–98).—*Phytophthora infestans* injured the leaves and fruit of tomatoes in 1890 in several parts of Connecticut. Injuries to the leaves by *Cladosporium fulvum*, and to the fruit by *Macrosporium tomato*, Cke., and by *Fusarium lycopersici*, Sacc., are also reported. A destructive epidemic was observed among the tomato worms (*Phlegethontius carolina* and *P. celeus*) infesting a field in the vicinity of New Haven. It was found that this was caused by the fungus "*Empusa grylli*, form *aulicæ*, which is common on hairy caterpillars and has also been found this year on a number of naked cutworm larvæ (*Lithophane*, *Mamestra*, and *Agrotis*). It was found easy to propagate it on young tomato worms, which died after the usual period of incubation (6 to 10 days) with the characteristic symptoms." Another species of *Empusa* was very destructive to the grape leaf hopper (*Typhlocyba vitis*) in a vineyard at Meriden and was also found at New Haven on the cabbage worm (*Pieris rapæ*), on which insect it was successfully bred at the station. "What appears to be the same *Empusa* has kindly been sent from New Jersey by Professor Halsted, on *Pieris* larvæ, and the same fungus is reported to have killed vast numbers of the clover weevil in that locality during the past season."

Peronospora cubensis was observed on cucumbers at South Manchester, Connecticut.

The mildew of lima beans (*Phytophthora phaseoli*), described and illustrated in the report of the station for 1889, page 167 (see Experiment Station Record vol. II, p. 482), was again destructive in 1890, making its appearance in a number of localities in Connecticut. Several varieties of pears of the Japanese strain have shown themselves very susceptible to injury by a rust (*Gymnosporangium globosum*) derived from the red cedar. This rust is also found on apples, quinces, etc., in Connecticut, but does not attack the ordinary varieties of pears.

"A mildew, which appears to be the form described by Peck as *Ramularia rufomaculans* on another member of the same family (*Polygonaceæ*), has been observed in several localities on buckwheat."

A clover rust referred to in the Annual Report of the station for 1889 as caused by *Uromyces striatus*, proves to be *U. trifolii*, Wint., and was very abundant in 1890.

Puccinia rubigo vera, D. C., and *Urocystis occulta*, Rabh., were very common on rye in 1890.

Some results from the application of fungicides (pp. 99–104).—Successful experiments are reported with Bordeaux mixture and ammoniacal carbonate of copper for leaf spot of quince (*Entomosporium maculatum*, Lev.), black rot of grapes, anthracnose of grapes, and strawberry rust; and with Bordeaux mixture for leaf spot of plums and cherries and potato blight. The effect produced by the treatment with Bordeaux mixture for the leaf spot of quinces is strikingly illustrated in two plates

showing treated and untreated quince orchards. Experiments with sulphur for the smut of onions, continued in 1890, were inconclusive.

Fungicides and their application (pp. 104–113).—Suggestions are made with reference to the use of fungicides; spraying apparatus of various kinds is described and illustrated; directions are given for the preparation of Bordeaux mixture and carbonate of copper solution. A combination of a copper wash-boiler, a "Hydronette" force pump, and a Vermorel nozzle, devised by the author and used successfully at the station, is described in detail. "The advantage of this apparatus is that in addition to its cheapness (its total cost is a little over $8), it leaves the force pump free for other uses, when not wanted for spraying, and is also readily made by any one of ordinary intelligence."

PROTEIDS OR ALBUMINOIDS OF THE OAT KERNEL, T. B. OSBORNE, PH. D. (pp. 114–161).—This contains a full description of the author's investigation of the proteids of the oat kernel, allusion to which has been previously made in Experiment Station Record, vol. II, p. 304. The author summarizes the results of previous investigations in this direction as follows:

> The proteids contained in or derived from the oat grain have been specially studied by J. P. Norton, Baron von Bibra, and Dr. W. Kreusler.
>
> Norton* recognized three proteids, viz, (1) *Albumin*, 0.5 to 2.17 per cent, which was taken up from the "epidermis" (after starch had been mechanically removed by elutriation with slightly ammoniacal water) by boiling with acetic acid, and was precipitated by neutralizing the solution. (2) *Casein* (or *avenine*), 15.76 to 17.72 per cent, which was dissolved in the slightly ammoniacal water used in separating starch, and thrown down by acetic acid. (3) *Glutin*, 1.33 to 2.47 per cent, extracted by alcohol and separated from oil by means of ether, and from sugar by water.
>
> Von Bibra† found that no coherent gluten could be got from oat flour by kneading in water. He recognized *albumin*, 1.24 to 1.52 per cent, precipitated by boiling the cold-water extract of the ground oats; *casein*, 0.15 to 0.17 per cent, the body separating from the hot-alcohol extract on cooling; *plant gelatin* (Dumas' *glutin*, Tadder's *gliadin*), 3 to 3.25 per cent, the substance soluble both in hot and cold alcohol; and nitrogenous substance, insoluble in water and alcohol, 11.35 to 14.85 per cent.
>
> Kreusler‡ found *oat gliadin* soluble in weak alcohol and *oat legumin* soluble in very dilute alkali.

The author studied preparations obtained from the extractions of freshly ground oats with hot alcohol of 0.915 specific gravity; with alcohol after previous treatment of oats in separate cases with water, with a 10 per cent solution of sodium chloride, and with water and salt solution successively; with water alone; with a 10 per cent solution of sodium chloride at 15° to 20° C.; with a similar salt solution after previous treatment of the oats with cold alcohol of 0.9 specific gravity; by 0.2 per cent potassium hydrate solution alone, and after previous extraction of the oats with alcohol of 0.9 specific gravity, and with water for 1 hour, and for 24 hours; and with a 10 per cent

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*Am. Jour. of Sci. and Arts (second ser.), III, 330 (1845), and ser. V., 22 (1848).

† Die Getreidearten und das Brod, Nürnberg (1860).

‡ Jour. f. prak. Chem, CVII, 17 (1869).

solution of sodium chloride at 65° C. The following summary of the results of these studies is given by the author:

(1) The proteid body removed from fresh-ground oats by direct extraction with weak alcohol, first observed by Norton and by him designated *glutin*, when dehydrated by absolute alcohol and dried over sulphuric acid, is a light-yellowish powder, insoluble in pure water as well as in absolute alcohol, soluble in mixtures of alcohol and water, soluble also in dilute acids and alkalis, and from these solutions thrown down by neutralization. Separated from its solution in alcohol of 60 per cent by evaporating off the alcohol, it forms a yellowish, slimy mass. Its composition is given in the [following] table under I. This substance is remarkable for its considerable content of sulphur, which is exceeded by that of keratin alone among the proteids, and is otherwise equaled only by that recorded in some analyses of serum-albumin.

(2) When the substance described above is heated with dilute alcohol for some time it coagulates and becomes insoluble in that liquid, but without apparent change of composition. II is the average of three accordant analyses of this coagulated form of the alcohol-soluble proteid.

Kreusler obtained this material from the oat, but what Ritthausen and he named *oat gliadin* was a product of its further alteration by the chemical treatment to which it was subjected with a view to purification.

(3) When oats are first treated with water or 10 per cent solution of common salt, before extraction with dilute alcohol, the alcohol-soluble proteid undergoes alteration. and a body of different composition and properties results. In the table, III is the mean of closely agreeing analyses of this substance; it is much more soluble in dilute alcohol than I, and is not coagulated or transformed into an insoluble modification. When wet with absolute alcohol, the moisture attracted from the air soon renders it gummy and tenaciously adhesive, unlike I.

Its composition, as regards carbon, hydrogen, and nitrogen, is very near to that found by Dumas and Cahours, and also by von Bibra, for *gliadin* or *plant-gelatin* (extracted by hot alcohol from wheat gluten and remaining dissolved in the alcohol when cold).

(4) The chief proteid extracted by cold 10 per cent salt solution behaves toward reagents like the *myosin-globulin* from animal muscle, as first stated by Weyl. Contrary to Weyl's observations, however, the coagulation temperature (80° to 100° C.) is much higher than that of animal myosin (55 to 60° C.). This proteid appears to be the result of a transformation similar to that by which myosin is formed from myosinogen. Its composition is given under IV, and is very near to that of muscle myosin. The greatest proportion of this proteid extracted by salt solution from the oat was 1.3 per cent.

(5) The proteid extracted, after complete exhaustion of the oats with alcohol of 0.9 specific gravity, by 10 per cent salt solution (analysis under V), and that dissolved out by dilute potash (analysis under V*a*), have so nearly the same composition as the globulin extracted by salt solution directly that they may be regarded as originally identical, IV representing the soluble form V, and V*a* the insoluble or "albuminate" modification.

(6) When ground oats are directly extracted by weak potash solution without previous treatment with water or dilute alcohol, nearly the whole of the proteids is dissolved. The substance so extracted, after completely removing the body soluble in weak alcohol, is perhaps the same as that first designated *avenine* by Johnston and Norton, who extracted oats with dilute ammonia water. Its composition, as indicated by analysis of a single preparation, is stated under VI.

(7) When ground oats are exposed to the action of water, a large share of the proteids becomes insoluble in dilute potash solution, the amount so rendered insoluble increasing with the duration of the contact with water. One hour's treatment with

water rendered one half, and 24 hours' treatment rendered two thirds insoluble in 0.2 per cent solution of potash. The composition of the part soluble in potash, after action of water (and removal of the alcohol-soluble proteid), as found in analyses, the average of which is stated under VII, is the same as that of the globulin soluble in salt solution, IV. This proteid, obtained by extraction with potash, *after* the action of water, is probably the substance which Kreusler converted into his *oat legumin* by the "purifying" process to which he subjected it. It is also the "protein body" which Norton extracted by weak ammonia and analyzed.

(8) When ground oats are extracted with 10 per cent sodium chloride solution heated to 65° C., a proteid separates on cooling, in the form of spheroids. This substance differs in composition and properties from that obtained by cold salt extraction as well as from all proteids hitherto described. It is soluble in pure water, is precipitated from such solutions by a little sodium chloride, is again dissolved by a certain additional quantity, and is precipitated completely by saturation with this salt. In the presence of a little sodium chloride and acetic acid it is soluble in alcohol of 0.9 specific gravity. From solutions in distilled water, as well as from those in sodium chloride brine, it has been obtained crystallized in regular octahedrons. Analysis (of spheroids) under VIII.

(9) The aqueous extract of ground oats was found, in agreement with Norton and Kreusler, to contain very little proteid substance. The proteids thus dissolved appear to be, first, an *acid-albumin;* second, a *globulin* or *globulins* similar in reactions to that extracted by 10 per cent salt solution, and third, a *proteose.* No true albumin was found in the water extract.

(10) In the salt extract a very small amount of a body was found, having the reactions of *albumin*, but not analyzed.

Table of composition of proteids from the oat kernel.

	I.	II.*	III.*	IV.	V.	Va.	VI.	VII.*	VIII.
Carbon	53.06	53.10	53.70	52.34	52.48	52.45	53.49	52.49	52.22
Hydrogen	6.94	6.91	7.00	7.21	6.94	6.92	7.01	7.10	6.98
Nitrogen	16.38	16.49	15.71	16.88	16.85	16.63	16.39	17.11	17.85
Sulphur	2.26	23.50	1.76	0.88	0.57	0.81	0.99	0.80	0.77
Oxygen	21.38		21.83	22.69	23.16	23.10	22.12	22.50	22.18
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Average of several analyses.

The numbers over the analyses in the above table correspond with those of the paragraphs in the foregoing summary.

GRASS GARDENING, J. B. OLCOTT (pp. 162–174).—An account of the grass gardens of the station at South Manchester and New Haven, with suggestions with reference to the management of such gardens and their value for experimental purposes.

FEEDING STUFFS (pp. 175–182).—Analyses of cotton-seed meal, linseed meal, oil-cake meal, malt sprouts, brewers' grains, middlings, corn and oat feed, "Buffalo Sugar Feed," and salt herrings with reference to both food and fertilizing ingredients, and of field-cured and ensiled maize kernels with reference to food constituents.

The comparison of field-cured and ensiled corn was made on material sent to the station for that purpose. The analyses of the dry matter are "practically identical" and "go to show that there had been no material change in the composition of the kernels in the silo."

On the market price of the ingredients of feeding stuffs.—The author compares the market prices of concentrated feeding stuffs, as cotton-seed and linseed meal, with those of the mill products and corn. He states that "in our ordinary mill feeds, carbohydrates cost as much as albuminoids," and gives in support of this the following statement of the average cost of food ingredients in these materials for the years 1888 and 1890:

[Cents per pound.]

	1888.	1890
Albuminoids (N. × 6.25)	1.6	1.4
Fat	4.2	2.9
Carbohydrates (including fiber)	0.96	1.4

"Cotton-seed and linseed meal, gluten meal, malt sprouts, and brewers' grains seem at present to be the most economical of our concentrated feeds."

THE COMPARATIVE EFFECTS OF PLANTING IN HILLS AND DRILLS ON THE QUANTITY AND QUALITY OF THE MAIZE CROP (pp. 183–194).—The piece of land used for this experiment was checked off into 24 twentieth-acre plats, so arranged that there were four rows of plats (north and south) with six plats in each row. Of these four rows of plats, the first row received 10.7 cords of cow manure per acre; the second row 13.3 cords of hog manure; the third row 1,700 pounds of a mixture consisting of 100 pounds of nitrate of soda, 80 pounds of sulphate of ammonia, 80 pounds of dried blood, 125 pounds of cotton seed meal, 90 pounds of dissolved boneblack, and 40 pounds of muriate of potash; and the fourth row received no fertilizers. Corn was planted on the first, third, and fifth plats in each row of plats, in drills 4 feet apart and with the stalks 10 inches apart in the drills, and on the remaining plats in rows likewise 4 feet apart, the hills being in different series of plats from 40 inches apart with four stalks in a hill, to 20 inches apart with two stalks in a hill.

"This arrangement of the field and fertilizers makes possible a comparison of the relative effects of planting in hills and drills on plats quite different as far as manuring goes, but otherwise believed to be quite uniform in quality. * * * In 1888 and 1889 this land had received very considerably more of both potash and phosphoric acid than had been removed in the crops of those years, but on the other hand the crops had removed some 60 pounds more of nitrogen from the soil per acre than had been replaced." An excess of seed was planted and the plants thinned out to the desired distances. The plants were all cultivated at the same time and in the same manner.

When harvested, "each crop was weighed and sampled from an area of one fortieth of an acre taken from the center of each plat." Analyses were made of the kernels and stover from each plat, which are given in

tables, and from these analyses the yield of dry matter and of each food ingredient is calculated for each plat and the averages for the plats receiving like applications of fertilizers.

In this experiment the maize planted in drills gave about 6 per cent larger yield of dry matter than the maize planted in hills, and also a larger yield of each food ingredient. * * * The composition of the crop, and therefore its feeding value per pound, were practically the same whether planted in hills or in drills.

The composition of the crops grown on the different fertilizers is practically the same; but where no fertilizer was applied the per cent of albuminoids in the crop is about 1.7 lower, with a corresponding increase in the per cent of fiber and nitrogen-free extract. * * *

It has been shown by our experiment of the 2 preceding years that the per cent of albuminoids in the crop may be strikingly increased or decreased by changing the distance of planting [see Annual Report of the station for 1889, p. 223, or Experiment Station Record, vol. II, p. 478].

The author gives tables showing the composition of the largest crop of dry matter raised in 1888 and 1889, and the largest yields in drills in 1890; the pounds of nitrogen, phosphoric acid, and potash applied to and taken from the soil in 1888, 1889, and 1890, and the gain or loss to the soil of these three ingredients by 3 years' cropping.

ON THE DETERMINATION OF PHOSPHORIC ACID IN PRESENCE OF IRON AND ALUMINA, S. W. JOHNSON, M. A., AND T. B. OSBORNE, PH. D. (pp. 195–197).—This is a comparison of the original and the "official" molybdic methods of determining phosphoric acid in the presence of iron and alumina on eight different materials. The authors point out the difference between the original molybdic method as elaborated by Sonnenschein and the method as recommended by the American Association of Official Agricultural Chemists, the precipitation being effected in the latter from a hot solution with digestion for 1 hour at 65° C., and in the former by adding "a large excess of molybdic solution [to the cold solution of the substance] and keeping for 4 to 6 hours at a temperature near to but not exceeding 50° C." With the "official" method, "when iron and aluminum are in the solution, these metals are to some extent carried down with the yellow precipitate, and when this is dissolved in ammonia they are also dissolved and pass into the alkaline filtrate and thence into the magnesium phosphate."

The results of determinations by both methods are tabulated. These results show differences of 0.5 per cent or over between the two methods in several instances, this difference amounting with one material (Keystone Concentrated Phosphate) to over 2 per cent of phosphoric acid. With a single exception the results were highest with the official method.

Georgia Station, Bulletin No. 12, April, 1891 (pp. 10).

FIELD EXPERIMENTS WITH FORAGE PLANTS AND ANALYSES OF THE PRODUCTS (pp. 47–54).—Tabulated data of yields and analyses of amber cane, white and yellow millo maize, Kaffir corn, Rural Branching

and Link Hybrid sorghum, pearl millet, teosinte, Blount Prolific corn, Brazilian Flour corn, and pop corn grown at the station in 1890.

Kansas Station, Bulletin No. 18, December, 1890 (pp. 18).

EXPERIMENTS WITH FORAGE PLANTS, C. C. GEORGESON, M. S., H. M. COTTRELL, M. S., AND W. SHELTON (pp. 175–191).—In view of the wide variation in the amount of rainfall in Kansas in different seasons, it is very desirable to find forage plants which will withstand drouth and furnish fodder for cattle when the corn crop fails. In 1890, for example, owing to drouth during July and August and the early frost in September, the corn crop on the farm of the Kansas Agricultural College did not furnish more than one third of the food required to carry the college herd through the winter. A table shows that the average rainfall in the months of May, June, and July, in the region of the station, has averaged 12.97 inches during the past 32 years. In 1889 the rainfall for 6 months amounted to 17.85 inches, while in 1890 it was only 6.54 inches.

Non-saccharine varieties of sorghum.—The experience at the station indicates that the non-saccharine varieties of sorghum should be planted in drills and cultivated in the same manner as corn, and that planting in rows 3 feet apart with the stalks from 4 to 8 inches apart in the rows, gives the most satisfactory results. "A greater yield per acre can be secured by planting the rows 2 feet to 30 inches apart, but the narrow space renders the work of cultivation much more difficult. As soon as the seed becomes hard the crop should be cut and shocked. * * * The heads should be cut off and threshed and the grain ground as fine as possible for the best results, and the fodder should be fed in racks."

The following is a summary of experiments in 1889 and 1890 with six non-saccharine varieties of sorghum:

Varieties.	1890.		1889.	
	Dry forage per acre, tons.	Cleaned seed per acre, bushels (60 lbs.).	Dry forage per acre, tons.	Cleaned seed per acre, bushels (60 lbs.).
Brown dhoura	7.04	*0.0	13.5	40.0
Egyptian Rice corn	3.47	16.5		
Kaffir corn (white)	3.31	6.0	7.0	60.0
Red Kaffir corn	4.20	19.1	9.0	71.0
White millo maize	5.29	2.2	15.0	57.0
White African sorghum	5.48	18.3		

*Killed by frost before seed matured.

Brief descriptive notes of each of the above-mentioned varieties were given, as well as a list of 45 imported varieties, chiefly from India and China, which were tested in 1890. Tabulated data and descriptive notes are given for eight of these foreign varieties which matured seed before frost.

(3) Teosinte yields heavy crops of excellent forage, much relished by stock. The average of a 3 years' test is a yield of 23.9 tons per acre.

Varieties of millet.—The following is a summary of a test with five varieties of millet in 1890:

Varieties.	Yield of hay per acre.	Days from seeding to heading.	Days from seeding to cutting.
	Tons.		
Broom corn	2.35		51
Common	2.40		65
German	2.65		65
Golden Wonder	1.95		85
Hungarian		44	51

Miscellaneous forage plants.—Brief notes are given on experiments with teosinte (*Euchlæna luxurians*), pearl millet, spring vetches, yellow lupine, thousand-headed kale, several varieties of soja beans (*Glycine hispida*), and other Japanese forage plants. The Kansas stock melons are described as a "non-saccharine variety of the watermelon, or possibly a cross between the citron and the watermelon, as the fruit partook of the solid character and lack of sweetness of the former, while it had the shape and size of the latter."

The flesh of these melons is firm and solid throughout, with comparatively few seeds. Cattle and hogs eat them greedily, but they have but little food value. An examination kindly made by the chemical department of this station showed them to contain 95 per cent of water and only 5 per cent of dry matter. They were fed experimentally to a portion of the herd, which will be reported on later. It may here be remarked that while they did not furnish much nourishment, they gave the animals a better appetite for dry food, and thus indirectly influenced the productive capacity of the stock. They furnish in a cheap form the succulent food which is so intensely craved by cattle in the winter months.

Varieties of silage corn.—Tabulated data are given for 14 varieties of corn tested in 1890.

Sorghum and corn for silage.—Tabulated data are given for 14 fifteenth-acre plats on which corn and sorghum were planted separately and also together in alternate rows and in the same rows. The average yields per acre were as follows: Corn and sorghum in alternate rows, 12.29; corn and sorghum in the same rows, 14.74; corn alone, 10.06; sorghum alone, 16.42 tons.

The sorghum when grown alone outyielded any combination of the two; but it is worthy of note that while the average of the plats with corn and sorghum mixed in the same rows reached 14.74 tons per acre, the average of the plats on which corn and sorghum are grown singly reaches only 13.24 tons per acre, the result thus supporting the theory of the effect of a mixture.

Summary.

(1) The non-saccharine sorghums are among our best drouth-resisting plants, and among them are several sorts that will yield good crops of seed in dry seasons, and the seed will compare favorably with corn for food.

(2) Of several varieties of millet tested, German millet gave the best yield of hay, followed in order by Hungarian, common, broom corn and Golden Wonder millet.

(4) Pearl millet has been a failure for three successive seasons, owing mainly to the apparent impossibility of getting a stand.

(5) Spring vetches failed to produce a paying crop in 1890.

(6) Yellow lupine was a failure in 1890.

(7) When roots or silage are not grown, Kansas stock melons can be grown and fed to advantage along with hay or other dry fodder. The yield is heavy, and the cost of culture and handling but slight.

(8) Thousand-headed kale will give a fair yield of forage, but heavier crops of more palatable feed can be grown at the same cost.

(9) Certain early varieties of the Japanese soja bean promise to be of much value for this country as heavy producers of a highly nitrogenous food.

(10) *Coix lachryma* and *Panicum frumentaceum*, two Japanese forage plants, were failures here in 1890.

(11) In a test during the past dry season of fourteen varieties of silage corn, only the following four kinds yielded more than 12 tons of silage per acre, viz, Mosby Prolific 14.39, Sheep's Tooth 12.92, Southern Horse Tooth 12.37, and Shoe Peg 12.15 tons per acre.

(12) A verdict of "not proven" must be given in the trial of growing a mixture of corn and sorghum *vs.* corn and sorghum grown singly, though there is some evidence in support of the theory that a mixture increases the yield.

Kansas Station, Bulletin No. 19, December, 1890 (pp. 10).

NOTES ON VEGETABLES, E. A. POPENOE, M. A., AND S. C. MASON, B. S. (pp. 193–202).—*The germination of weeviled peas.*—In view of differences of opinion among authorities as to the amount of injury to the seed of peas from the attacks of the pea weevil (*Bruchus pisi*), the following experiments were made at the station:

A germination test of weeviled beans in the greenhouse gave out of 1,800 beans, representing eighteen sorts, the following results: Fifty per cent started; of these, three fifths might have grown into plants, as the injury was restricted to the seed leaves; but the remaining two fifths were variously mutilated by the loss of a part or the whole of the germ or plumule, so that under no circumstances could they have made plants. * * * In a check lot of perfect beans of the same varieties and in the same numbers, planted side by side, 95 per cent germinated.

Of 500 peas of ten sorts tested in a similar manner, but one fourth germinated, and the partial destruction of the cotyledons rendered the further growth of those doubtful. A check lot of the same number of sound peas gave a germination of 97 per cent. An examination of 275 injured peas showed but 69 in which the germ was not wholly or partially destroyed.

In a field test of the growth of sound as compared with weeviled peas, the results were more decisive from a practical standpoint. In this test 23 varieties were represented, each by 100 sound and 100 weeviled peas, taken as they came, without further selection. The seeds were planted in the garden in parallel rows, the sound and weeviled peas of each sort side by side, the rows 18 inches apart. The planting was done on the 5th of June, and the dryness of the season hindered the perfect germination and growth to a noticeable degree. Of the sound peas 68 per cent came up, and 64 per cent made strong plants. In 10 varieties of the weeviled peas, no seeds germinated; the remaining 43 varieties were represented in all by 58 plants or 4.4 per cent, in germination, of which but 49, or 3.8 per cent, grew to average size and strength.

The inference is plain that weeviled seed should not be planted, because it is worthless compared with sound seed, and because by planting infested seed without

more care than usually taken to destroy the contained weevils, one thus simply propagates the insect for the sake of a minimum of return in plants. The proper course is to throw infested seed into the fire as soon as the insects are detected. As an easy mode of separating the sound from the unsound seed, it is suggested by Professor Riley, in his Third Missouri Report, that if thrown into water the infested seed will float, while the sound seed, being heavier, will sink.

Second-crop potato seed.—Tabulated data are given for an experiment in which potatoes were grown from the seed of first and second crops. The results indicated that by the use of second-crop seed, there is no gain in earliness, but the yield and size of tubers are greater. In a second crop of potatoes grown in 1890 at the station, the nine varieties planted yielded from 67 to 173 bushels per acre. "The product was of unusually fine quality and the yield a very good one, when it is considered that potatoes of ordinary planting were almost a failure in this section of the country."

Varieties of beans.—Out of 194 varieties planted in 1890 only 19 survived the drouth sufficiently to give even a moderate yield. Of these, Henderson Bush Lima, Dwarf Carolina, and a local variety known as Belcher gave especially good results. Descriptive notes are given on 10 varieties of Japanese beans grown at the station.

Cabbages.—The following varieties proved the most productive in the dry season of 1890: *Early.*—Burpee All Head, Early Newark Flat Dutch, Early Schweinfurth; *medium.*—Henderson Succession, Reynolds, Cassell; *late.*—Henderson Selected Late Flat Dutch, Burpee Surehead, Warren Improved.

Maine Station, Annual Report, 1890, Part II* (pp. 48).

TEST OF DAIRY COWS (pp. 17–42).—This is a continuation of the test of Ayrshire, Holstein, and Jersey cows, the first year's report of which was given in the Annual Report of the station for 1889, p. 106 (see Experiment Station Record, vol. II, p. 647). Each breed was represented by two registered cows, although the test with one of the Holsteins lasted but a single year. The food given in 1890 was the same as in 1889, except that no silage was fed and that one Holstein received a certain amount of middlings (170 pounds during the year) in addition to the regular ration. The daily ration consisted of 6 to 8 pounds of a mixture of two parts by weight of corn meal, and one each of cotton-seed meal and wheat bran, as much hay as the animals could eat clean, and pasturage during the summer months. A record was kept of the amount of each kind of food consumed by each of the cows during 1889 and 1890. In the present report the results for the 2 years are considered together.

Tabulated data are given for each cow as to the food eaten during the 2 years, cost of the same, yield and relations of milk and milk

*For abstract of part I of this report, see Experiment Station Record, vol. II, p. 345.

products, composition of the whole milk, skim milk, buttermilk, and cream, cost of food per pound of milk, food materials retained in the waste products of the dairy, and the loss of fat in the skim milk and buttermilk. The age, live weight, cost of food per year "reckoned at what are assumed to be average market values," average production of milk and butter, etc., are given for each animal as follows:

Record of individual cows.

Breed.	Age at beginning of the experiment.	Weight at beginning of the experiment.	Averages of the two years.										
			No. days milked per year.	Yield of milk per year.	Yield of milk solids per year.	Yield of butter fat per year.	Yield of butter per year.	Milk per pound of butter.	Cream per pound of butter.		Cost of food consumed per year.	Cost of food per pound of milk produced.	Cost of food per pound of butter.
Holstein:	Yrs.	Lbs.		Lbs.	Lbs	Lbs	Lbs	Lbs.	Lbs.	In.		Cents.	Cents.
No 1	6½	1,275	336	9,176	1135	319	317	28.96	5.01	2.52	$71.24	0.78	22 63
No. 2*	....	1,175	293	7,562	893	251	224	33.79	4.34	2.17	70.42	0.931	31.44
Ayrshire:													
No. 1	7	1,050	287	6,120	781	214	199	30.67	5.20	2.61	61.77	1.009	30.95
No. 2	4	1,020	291	7,105	906	253	197	36.02	4.87	2.43	63.21	0.89	32.06
Jersey.													
No. 1	7	870	348	6,540	987	344	374	17.46	4.18	2.06	59.74	0.916	15.96
No. 2	3½	920	336	4,381	667	250	255	17.30	3.95	1.98	58.76	1.345	23.08

* Test lasted only one year.

It is to be noticed that the expense of feeding a Holstein animal averaging 1,200 pounds in weight is only $11 per year more than the cost of feeding a Jersey animal averaging in weight only about 900 pounds; or in other words, the expense of feeding the heavier animals has been only about 18 per cent more than that of maintaining the lighter animals, whereas the Holsteins exceed the Jerseys in weight about 33 per cent. This is equivalent to saying that the quantity of food has not been in proportion to the weight of the animals, and * * * it is a well-recognized fact that the food of an animal does not increase in proportion to the increase in weight, or in other words, a small cow requires a larger maintenance ration in proportion to her weight than a large cow.

[The figures show further] that the Holsteins have produced milk solids considerably in excess of the other two breeds, and that the Ayrshires and Jerseys have differed very little in this respect. * * * When, however, we come to the consideration of the yield of fat we find that the Jerseys excel and that the Ayrshires stand lowest in the scale. * * * The food value of a quart of Jersey milk, such as that produced by the station animals, is worth 25 per cent more for purposes of nutrition than is the Holstein milk. While it may not be possible to grade the retail price of milk according to its quality, it would be entirely just for the milkman who is selling the product of a Jersey herd to receive a larger price than that which is paid for Holstein or Ayrshire milk. * * * The above table makes it very clear that cream is not of uniform value, and that the individuality of animals has a very marked influence upon the cream that is produced. Taking the average of a 2 years' record we see that the amount of cream required for a pound of butter has varied from 5.2 pounds in the case of the Ayrshire [No. 1] to 3.95 pounds in the case of the Jersey [No. 2]. The custom so far in Maine has been to pay the same price for equal volumes of cream, without regard to its source. This may be rank injustice, as the facts show.

In calculating the cost of the milk and butter produced per pound the first cost of the food alone is considered, no allowance being made

for the fertilizing ingredients of the food or the value of the buttermilk and skim milk.

The tabulated data show that "the Holstein milk cost the least and the Jersey milk the most when quantity alone is considered." The butter fat in the milk of the Ayrshires and Holsteins cost on an average "from 20 to 30 per cent more than in the case of the Jerseys."

Some interesting facts concerning the composition of the buttermilk, skim milk, and cream are presented in the following table, which is taken from the report:

Average composition of skim milk, cream, and buttermilk of the different breeds for two years.

	Skim milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct*
Holstein	9.50	0.52	25.[illegible]0	18.30	9.70	0.45
Ayrshire	10.40	0.85	25.00	17.00	10.00	0.44
Jersey	10.50	0.37	27.90	19.80	10.30	0.19

First of all, it does not appear to be true that the cows producing the most and the richest cream are those that furnish the poorest skim milk. The proportion of cream from the Jersey milk has been much larger than from either of the other two breeds, and at the same time the Jersey skim milk proves to be the richest of all. * * * It is true with regard to both skim milk and buttermilk that [in solids] they follow the order of richness of the whole milk from which they come, or in other words, the poorer the whole milk, the poorer are the waste products of the dairy.

As will be seen, the average loss of fat in the skim milk and buttermilk was least with the Jerseys. "The Jerseys have uniformly produced the richest cream," as was shown both by analysis and by the churn. "As the time of parturition has approached, the amount of fat has been less in proportion to the other solids in the cream than while the cows were 'fresh.'"

The following statement shows the loss of milk solids and fat in the buttermilk and skim milk per year:

Average loss of solids and fat in buttermilk and skim milk for 2 years.

	Holstein.		Ayrshire.		Jersey.	
	No. 1.	No. 2.*	No. 1.	No. 2.	No. 1.	No. 2.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Yield of total milk solids	1,185	893	781	906	987	667
Yield of total cream solids	375	251.5	242.4	231.1	419	273.3
Yield of total skim milk solids	721.2	610.8	508.5	641.4	521.8	353.6
Yield of total buttermilk solids	107.8	60.8	73.5	60.9	105.7	62
Average per cent of total fat lost in buttermilk and skim milk	10.3	16.4	13.7	26.3	3.5	7.1

* Tested only one year.

The milk of all the cows was treated exactly the same, being "set in the same cabinet, with water at the same temperature, and for the same length of time."

The total amount of solid matter contained in a year's milk of the various animals ranged from 667 pounds up to 1,135 pounds, or an average of 895 pounds per year. There was retained in the skim milk and buttermilk from 416 up to 829 pounds of dry matter, or an average of 638 pounds of dry matter. This is 71 per cent of the total yearly production, or stated in another way, in making butter there is sent away from the farm only 29 per cent of the dry matter which the cows produce. It is worthy of note that seven eighths of this is contained in the skim milk.

Estimating the solids in the buttermilk and skim milk at 2 cents per pound, the average value of these per cow is calculated at $12.76 yearly.

MECHANICAL LOSS OF BUTTER FAT (pp. 43–45).—In previous experiments at the station it has been noticed that "the total amount of solids in the whole milk is not accounted for by the amount of solids in the skim milk and sour cream. The loss seems to have fallen especially upon the butter fat. It was found that not far from 10 per cent of the fat in the whole milk failed to appear in the skim milk and sour cream."

This matter was carefully tested in two separate trials by calculating for each four cows the actual amount of solids and fat in the whole milk and those in the skim milk and sour cream, during 5 days; and further by observations on over 200 pounds of milk of known composition. The data obtained in the latter test were as follows:

	Solids.	Fat.
	Pounds.	*Pounds.*
Contained in the whole milk	26.83	8.09
Contained in the sour milk and sweet cream	26.68	8.02
Contained in the sour milk and sour cream	26.34	7.77
Fat not accounted for in sour milk and sour cream	....	*0.32

*Or 4 per cent.

"In no instance was the amount of fat in the skim milk and the sour cream equal to that of the whole milk, the discrepancy or apparent loss, amounting in the several cows to from 4 to 7 per cent of the total fat in the milk. In the special trial, where a large quantity of milk is used, the fat of the sweet cream plus that of the skim milk accounts for practically that of the whole milk." The sour cream, however, "contained by analysis a quarter of a pound less of fat than the sweet cream."

EFFECT OF DELAY IN SETTING MILK (pp. 46–48).—Tests made to determine whether a loss of fat is entailed by allowing milk to stand from one half to an hour after milking before straining and setting, indicated that this treatment "does not seem to materially affect the completeness with which the cream will rise."

THE PREPARATION OF A RATION FOR MILCH COWS (pp. 49–51).—This is a comparison of the value of chopped and unchopped hay for milch cows. The trial was made in connection with the experiment with different breeds, described above. For 51 days the hay was chopped fine, moistened, and thoroughly mixed with the grain, no

other change being made in the ration. At the end of this time the animals were changed to the ration previously given, the hay being fed unchopped and the grain dry. Data as to the rations fed, composition of the milk, and the yield of milk and butter during each period are given for five cows. Regarding the value of the chopping and mixing, "there is no evidence that they had any effect."

MINERAL INGREDIENTS OF MILK, L. H. MERRILL, B. S. (pp. 52–57).—Analyses of the ash of whole milk and skim milk from Holstein, Ayrshire, and Jersey cows, and a calculation of the ash ingredients in 1,000 pounds of milk and skim milk, and in the whole milk and skim milk of a cow for 1 year for each of the three breeds.

The author finds the amount of potash and phosphoric acid contained in the milk and skim milk of one cow for 1 year to be as follows:

Yearly averages for one cow.

	Potash.		Phosphoric acid.		Total.
	Pounds.	Value.	Pounds	Value.	Value.*
Whole milk	11.16	$0.50	13.42	$1.07	$1.57
Skim milk	9.53	.43	11.50	.92	1.35
Cream, by difference	1.63	....	1.92	....	.22

* Potash at 4½ cents and phosphoric acid at 8 cents per pound

THE FAT GLOBULES OF MILK, L. H. MERRILL, B. S. (p. 58).—Tabulated data on the relative size and number of fat globules in the milk and skim milk of Holstein, Ayrshire, and Jersey cows.

As might have been expected, the larger globules have gone into the cream, leaving only the smaller ones in the skim milk. In no case do these average one half the size of those in the whole milk, and in the case of Jerseys they are less than one sixth as large. It is noticeable also that the globules in the milk of the two Jerseys are double the size of those of the other breeds, a fact which must in large part account for the ready creaming of this milk.

REPORT ON TUBERCULOSIS, F. L. RUSSELL, V. S. (pp. 59–64).—Notes on observations on two cases of tuberculosis in cows belonging to the college herd.

Massachusetts Hatch Station, Bulletin No. 13, April, 1891 (pp. 12).

DIRECTIONS FOR THE USE OF FUNGICIDES AND INSECTICIDES, S. T. MAYNARD, B. S. (pp. 3–10, figs. 3).—Brief directions for the preparation and use of sulphate of copper (blue vitriol), sulphate of iron (copperas), Bordeaux mixture, ammoniacal carbonate of copper, and Paris green, alone or in combination, for fungous diseases and insect pests of the pear, plum, peach, cherry, grape, strawberry, and potato. Spraying apparatus is illustrated.

GIRDLING GRAPEVINES, J. FISHER (pp. 11, 12).—An account of an experiment in 1890, in continuation of those reported in Bulletin No. 7 of the station (see Experiment Station Record, vol. II, p. 23), and the Annual Report for 1888 (see Experiment Station Bulletin No. 2, part I, p. 93). Analyses of samples of the grapes by C. A. Goessmann, PH. D., are also reported. As in the previous experiments, the grapes on girdled vines ripened earlier (11 days, in 1890), "were sweet, with about the right proportion of acid," and were considerably increased in size. On some portions of the girdled vines, however, the fruit was inferior or worthless, and the question whether continuous girdling is injurious to the vine is yet to be solved.

The article also contains brief notes on an experiment in which muriate and sulphate of potash were compared as fertilizers for grapevines.

Massachusetts Hatch Station, Meteorological Bulletin No. 29, May, 1891 (pp. 4).

A daily and monthly summary of observations for May at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Minnesota Station, Biennial Report, 1889 and 1890 (pp. 39).

This contains the reports of the director, agriculturist, entomologist, botanist, veterinarian, horticulturist, and chemist, and superintendent of the Owatonna substation, which include outlines of the work in the several departments of the station. The veterinarian, O. Schwartzkopff, D. V. M., reports that feeding tests with sheep indicated that the lead plant (*Amorpha canescens*) is not an injurious weed for these animals. He also gives a brief account of inoculation experiments with the virus of actinomycosis. In the case of three dogs and two cats the inoculation was unsuccessful, but a tumor, shown by microscopical diagnosis to be due to actinomycosis, was produced on a calf inoculated through the skin of the left lower jaw.

The station suffered a great loss by the burning of its office and laboratory building October 5, 1890, when the laboratory equipment, a large part of the library, all the reports, bulletins, and records, and many of the memoranda of station work were destroyed. During 1890 the mailing list of the station was increased from 4,000 to 20,000 names.

Missouri Station, Bulletin No. 14, April, 1891 (pp. 36).

FIELD EXPERIMENTS WITH CORN AND ROOT CROPS, H. J. WATERS.—A report on experiments which, with a few exceptions, were carried on during 1889 and 1890. They were mainly planned by J. W. Sanborn, B. S., director of the station until June 1, 1889, but were completed by the author. The work has been in the following lines: (1) Test of varieties; (2) manures; (3) preparation of soil for planting; (4) distance and thickness of planting; (5) cultivation of corn, (*a*) depth of cultiva-

tion, (*b*) effect upon soil moisture, (*c*) frequency of cultivation, (*d*) hilling and level culture, (*e*) tilled one way *vs.* cross-tilled; (6) drainage for roots and corn. Details are given in notes and tables.

Test of varieties.—Tabulated data are given for 41 varieties tested in 1889.

Edmond Dent and Cuban Queen—both yellow—led in yield among the early-maturing varieties, while Blount Prolific and Champion White Pearl of the white varieties, and Logan, Imperial, and Murdock Improved of the yellow are the most promising of the medium-maturing. Of the late-maturing, St. Charles White and Piasa King led in the yield among the white varieties, while Golden Beauty was, apparently, the best of the yellow.

The varieties were classified as early (maturing within 110 days), medium (120 days), and late (130 days). The following is a summary of the results by classes:

Summary showing yield, etc., of early, medium, and late-maturing varieties.

	Height of stalk.	Height of ear.	Yield of good ears.	Yield of nubbins.	Yield per acre.	Yield of fodder per acre.	Fodder per bushel of corn.
	Feet.	*Feet.*	*Pounds.*	*Pounds.*	*Bush.*	*Pounds.*	*Pounds.*
Average of 13 early-maturing varieties	8.8	4.2	276	54	47	2 592	54.6
Average of 16 medium-maturing varieties	10.1	5.0	325	52	53.9	3,350	61.6
Average of 12 late-maturing varieties	10.3	5.5	293	50	51.4	3,696	72.1
Average of all varieties tested	9.7	4.9	300	54	50.9	3,209	63.0

"From this table it appears that the medium-maturing varieties average the largest yield of corn, the late-maturing next, and early varieties the smallest."

Similar results obtained at the Illinois Station (see Bulletin No. 4 of the station) are cited.

The relation between the height of the stalk and the yield is indicated in the following summary:

Table showing relation of height of stalk to yield of variety.

	Height of stalk.	Height of ear.	Yield of corn per acre.	Yield of fodder per acre.	Fodder per bushel of corn.
	Feet	*Feet.*	*Bushels.*	*Pounds.*	*Pounds*
Average of 5 varieties showing smallest yield	8.5	3.9	40.1	2,012	50.2
Average of 5 varieties showing largest yield	10.7	5.5	61.5	3,832	62.3
Average of 5 varieties having shortest stalks	8.3	3.9	41.4	2,071	50.1
Average of 5 varieties having tallest stalks	11.0	6.0	55.9	3,988	71.3

The averages of the five varieties giving the smallest yield and of the five varieties having the shortest stalks are practically identical throughout. On the other hand, there is no relation between the average of the five varieties having the tallest stalks and the five varieties giving the largest yield.

The table points to the conclusion that the limit of profitable production has been reached in our very early varieties with a small growth of stalk, except when grown for a special purpose.

Experiments with manures.—The object of these experiments was to get light on the relative value of the different kinds of farm manures and the different methods of their preparation and application. The

report covers the work for 1889 and 1890. In both seasons the corn planted was a common medium yellow dent variety. No manure was applied in 1890. On eight manured as compared with four unmanured plats, barnyard manure (about ten loads per acre) gave an increase of about 46 per cent in 1889 and 33 per cent in 1890 in the yield of corn and fodder. Horse manure gave better results than cattle manure.

A comparison of the solid and liquid manure from cattle when both were saved together, and an equal weight of solid manure alone, showed the largest yield for the 2 years from the plat having the liquid manure saved with the solid. Plowing under gave better results than any other method of applying tested. No benefit was derived from the use of salt, lime, or land plaster, while wood ashes gave a material increase of crop. In the trial of commercial fertilizers the increase was not sufficient to warrant the expense. In these trials corn responded more readily to an application of potash than either phosphoric acid or nitrogen.

Preparation of soil for planting.—These and the remaining experiments reported in this bulletin were conducted on an upland clay loam with a clay subsoil. As a rule, tenth-acre plats were used. "The variety of corn grown in 1889 was St. Charles White, a large, late-maturing white dent, and in 1890 Cuban Queen, a small, early-maturing yellow variety."

The trial of fall and spring plowing for carrots and corn resulted in a draw. In the test of thorough, little, and no plowing for corn for the 2 years, there was no difference in the yield. The plat having no preparation yielded more corn in 1889 than either of those that had been prepared, and less in 1890. A comparison of deep and shallow plowing for corn in 1890 showed a gain of 4.8 bushels per acre or 11.9 per cent in favor of shallow plowing. Depth, 4 inches for the shallow and 10 inches for the deep plowing.

Subsoiling showed no gain in 1889 for ruta-bagas, nor in 1890 for corn. In both seasons the trial was made on tile-drained land, where subsoiling is supposed to show to the best advantage.

In 1889 a period of excessive rainfall, extending from May 15 to June 1, brought out some interesting facts in the growth of the corn planted on differently prepared plats.

During the time the soil was completely saturated with water the plants on the thoroughly prepared land made little or no growth, became pale, and apparently suffered materially. The plants on the plat having no preparation continued to grow vigorously and maintain a rich, healthy color. This was less marked on the plat having partial preparation, the plants appearing to occupy an intermediate position, as it were. There is no material difference in the surface drainage of the plats. The wet weather was followed by a drouth and excessive temperature, during which time the order of growth was completely reversed—the plants on the thoroughly prepared land making a good growth and showing the effects of the drouth much less than on either of the other plats.

Distance and thickness of planting.

An average of the two seasons' work shows no difference in the yield from planting 3 feet 9 inches apart each way with 2, 3, or 4 grains in a hill. When planted either thicker or thinner there was a decreased yield, which in the case of thicker planting was accompanied by a material increase in the per cent of nubbins.

Cultivation of corn.

A trial of deep and shallow tillage gave an increase of 14.3 bushels per acre, or 21.7 per cent of the whole yield in favor of shallow tillage in 1889, and an increase for

the same method of tillage in 1890 of 12.6 bushels per acre, or 30.6 per cent as an average of duplicate plats. Average of both seasons for all plats gave an increase of 13.5 bushels per acre, or 25.2 per cent. A plat in the set having no tillage, the weeds being removed with a sharp hoe without stirring the soil, yielded in both seasons for the same plat, more than the deep-tilled plats, but less than the shallow-tilled. Weekly determinations of soil moisture for 11 weeks, ending August 6, in 1890, showed that the shallow-tilled plats had an average of 11.6 per cent more moisture than the deep-tilled plats, and 10 per cent more than the plat receiving no tillage.

In a test of different depths of cultivation with the hoe, running from 1 to 5 inches deep, there was less difference in the yield than in any test of depth of cultivation where field implements were used. It is probable that the better conservation of moisture by deep hoeing counteracts and balances to some extent the effect of root mutilation, as the New York State Station has shown that the moisture increased regularly with the depth of stirring. In their test the soil was stirred with a hoe or spade, and no crop was grown on the land tested. Then a perfect mulch is formed, but, as explained in the body of this report, no such covering is made by the ordinary field cultivator when run deep.

A light mulch of fine earth in one case, of sand in another, and of chaff in a third, spread to a depth of one half inch, gave as large a yield for 1889 as two adjoining plats having thorough tillage. The mulched plats were never tilled.

In a test of deep and shallow tillage where the root mutilation was equal, there was a gain of 5 bushels per acre, or 10.4 per cent in favor of shallow tillage, due, presumably, to the increased amount of moisture conserved. An effort to determine the stage of development of the plant at which the ill effects of deep tillage are least felt, showed a gain of 5.3 bushels per acre, or 12.4 per cent from tilling shallow, when the plants are small, and deep afterwards, as compared with deep tillage early and shallow afterwards. The trial was not made in duplicate, and covers but one season. The results need confirmation. The result of the experiment with frequency of tillage for two years, shows no relation between the amount of cultivation and the amount of corn harvested, so long as the weeds are kept down. This is in accord with experiments at the New York, Ohio, and Illinois Stations. A test of hill *vs.* level cultivation, where all other things were equal, showed an increase of 2.6 bushels per acre or 3.7 per cent in favor of hilling. The results are not decisive enough to be conclusive, but point to a probable advantage from hilling. A comparison of tilling one way continuously and cross-plowing once for both seasons resulted in a gain of 2.9 bushels or 5.3 per cent in favor of cross-cultivation.

Tile drainage for roots and corn.

A trial of the value of tile drainage on rolling clay upland shows a gain of 1.18 tons of mangel-wurzels per acre or 13.7 per cent in 1889 in favor of drainage; while, for 1890 with corn, the results are reversed, giving the undrained plats an advantage of 3.7 bushels per acre or 7 per cent. So far, the results are inconclusive. In 1890, the moisture in the first 7 inches of the soil, in both drained and undrained plats, was determined weekly for 11 weeks, ending August 6, showing no difference in favor of either system.

Nebraska Station, Fourth Annual Report, 1890 (pp. 371).

This includes a brief résumé of the work of each department of the station; a subject list of Bulletins Nos. 1–15, and Press Bulletins Nos. 1–5; the Treasurer's report for the fiscal year ending June 30, 1890;

the text of the act of Congress of March 2, 1887, and of the act of the State legislature, approved March 31, 1887, assenting to the act of Congress; and reprints of Bulletins Nos. 12–15 of the station. The subjects treated in these bulletins are: Bulletin No. 13, Experiments in the Culture of the Sugar Beet in Nebraska, H. H. Nicholson, M. A., and Rachel Lloyd, Ph. D. (see Experiment Station Record, vol. II, p. 111); Bulletin No. 14, Insects Injurious to Young Trees on Tree Claims, L. Bruner (see Experiment Station Record, vol. II, p. 115); Bulletin No. 15, Meteorological Report for 1889, DeW. B. Brace, Ph. D., and Soil Temperatures and Farm Notes, J. G. Smith, B. S. (see Experiment Station Record, vol. II, p. 240); Bulletin No. 12, Field Experiments for 1889, J. G. Smith, B. S. (see Experiment Station Record, vol. I, p. 254).

Nebraska Station, Bulletin No. 17, June 6, 1891 (pp. 72).

FIELD EXPERIMENTS AND OBSERVATIONS FOR 1890, J. G. SMITH, B. S. (pp. 1–32).—These were in continuation of those for 1888 and 1889, reported in Bulletins Nos. 6 and 12 of the station (see Experiment Station Record, vol. I, pp. 121 and 254). Drouth materially interfered with field work at the station, and the results for 1890 are comparatively meager. The subjects considered in the report are grasses and clovers, oats, silos and silage, and rainfall and evaporation.

Grasses and clovers (pp. 1–3).—Redtop (*Agrostis vulgaris*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), red clover (*Trifolium pratense*), alsike clover (*T. hybridum*), and white clover (*T. repens*) endured the drouth well and "seem to be the only species to be depended on in all seasons."

Alfalfa, which gives such abundant crops on bottom lands and under irrigation, though a strong grower does not seem to do well on upland meadows. It continued green and fresh during the entire season, but the yield does not compare with that of red clover.

The native wheat grass or blue joint (*Agropyrum glaucum*), resembling alfalfa in its strong and vigorous growth, makes too coarse hay and forage to compete with the finer-leaved cultivated species. It is not a success in this portion of the State, or at least not on upland soils. Its value farther west remains undisputed.

The only grasses now alive in the garden besides those mentioned above, are meadow brome grass (*Bromus pratensis*), tall meadow oat grass (*Arrhenatherum avenaceum*), sheep's fescue (*Festuca ovina*), red fescue (*F. rubra*), Kentucky blue grass (*Poa pratensis*) and sainfoin (*Onobrychis sativa*).

Oats (pp. 3–7).—Brief notes are given on the growth and yield of ten varieties of oats. In the dry season of 1890, press drilling, which puts the seed down deeper, gave a better stand, larger yield, and less loss by shattering than ordinary drilling or broadcasting.

Silos and silage (pp. 7–22).—Compiled statements are made concerning the advantages and disadvantages of silage, and replies to a circular of inquiry are given from five farmers in Nebraska who have successfully used the silo and found it to be an economical means for the storage of fodder.

Rainfall and evaporation for 1889 (pp. 23-32).—Tabulated data are given for six rain gauges and the same number of evaporimeters placed in different parts of the station farm. The observations were made from April 8 to November 1, inclusive.

METEOROLOGICAL REPORT FOR 1890, DeW. B. BRACE, PH. D., AND H. N. ALLEN, B. S. (pp. 33-72).—This is a continuation of the observations for 1888 and 1889, reported in Bulletins Nos. 6 and 15 of the station (see Experiment Station Record, vol. I, p. 123, and vol. II, p. 240), with the addition of data from six evaporimeters suspended at elevations of 4, 22, 40, 60, 80, and 100 feet, for the months of June to October inclusive; from six rain gauges for the months of April to October, inclusive; and from soil thermometers at depths of from 1 to 36 inches for the months of March to December, inclusive. The yearly summary is as follows: *Pressure* (inches).—Maximum 30.98; minimum, 29.36; mean, 30.08; annual range, 1.62; maximum daily range, 0.85. *Air temperature* (degrees F.).—Maximum, 103; minimum, —16; mean, 50.67; annual range, 119; maximum daily range, 47. *Humidity*.—Mean relative humidity, 67.95. *Precipitation*.—Total (inches), 14.81; number of days on which 0.01 inch or more of rain fell, 55. *Weather*.—Number of clear days, 136; number of fair days, 144; number of cloudy days, 85. *Wind*.—Prevailing direction, N and S; maximum velocity (miles per hour), 58; total movement (miles), 116.095. *Soil temperature* (degrees F.).—Maximum and minimum from March to December, 1 inch, 105 to 19; 3 inches, 101.5 to 24; 6 inches, 94 to 29.5; 9 inches, 89.5 to 32.2; 12 inches, 84 to 34; 24 inches, 70.5 to 39; 36 inches, 67.5 to 41.7.

Nevada Station, Third Annual Report, 1890 (pp. 38).

REPORT OF DIRECTOR, S. A. JONES, PH. D. (p. 4).—A brief statement regarding the work of the station.

FINANCIAL REPORT (pp. 5, 6).—This is for the fiscal year ending June 30, 1890.

REPORT OF AGRICULTURIST AND HORTICULTURIST, W. S. DEVOL, B. AGR. (pp. 6-30).

Forage plants (pp. 6-16).—Brief descriptive notes on the following species of plants sown on fortieth-acre plats in 1889, with a view to testing their adaptability to the dry climate of Colorado: Texas blue grass (*Poa arachnifera*), blue grass (*P. pratensis*), fowl meadow grass (*P. serotina*), wood meadow grass (*P. nemoralis*), redtop (*Agrostis vulgaris*), creeping bent grass (*A. stolonifera*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), Italian rye grass (*Lolium italicum*), perennial rye grass (*L. perenne*), meadow fescue (*Festuca pratensis*), tall fescue (*F. elatior*), red fescue (*F. rubra*), tall meadow oat grass (*Arrhenatherum avenaceum*), meadow foxtail (*Alopecurus pratensis*), Bermuda grass (*Cynodon dactylon*), velvet grass (*Holcus lanatus*), Johnson grass (*Sorghum halepense*), sweet vernal grass (*Anthoxanthum odoratum*), Hungarian grass (*Setaria italica*), golden millet (*S. italica*), pearl millet

(*Pennisetum spicatum*), red clover (*Trifolium pratense*), white clover (*T. repens*), alsike clover (*T. hybridum*), Japan clover (*Lespedeza striata*), spike clover or sweet clover (*Melilotus alba*), alfalfa (*Medicago sativa*), sainfoin (*Onobrychis sativa*), serradella (*Ornithopus sativus*).

Vegetables (pp. 16–30).—Brief notes on tests of 7 varieties of muskmelons, 6 of watermelons, 8 of potatoes in 1889 and 92 in 1890, 6 of sweet corn, 15 of beans, 24 of radishes, and 14 of cucumbers.

Fruits (p. 30).—A tabular statement of the number and varieties of trees planted in 1890.

REPORT OF ENTOMOLOGIST AND BOTANIST, F. H. HILLMAN, B. S. (pp. 31–34).—A brief outline of the work of the year.

REPORT OF CHEMIST, J. W. PHILLIPS, D. SC. (pp. 35–38).—This includes tabulated analyses of fifteen samples of soils from different localities in Nevada.

New Jersey Stations, Bulletin No. 79, February 28, 1891 (pp. 20).

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES, E. B. VOORHEES, M. A.—Experiments were made in 1890 on two different farms within the State for the purpose of testing the effects of different amounts of nitrate of soda on tomatoes, when used alone or in connection with phosphoric acid and potash, and when applied all at one time or in two separate portions.

Each experiment was made on 12 twentieth-acre plats, treated as follows: Nitrate of soda, 8 and 16 pounds, was used alone and in connection with a mixture of 8 pounds of muriate of potash and 16 pounds of boneblack superphosphate, being applied in four cases all at one time, previous to setting the plants, and in four cases in two separate equal applications, one previous to setting and the other a month later. One ton of barnyard manure was used on one plat; one plat received a mixture of 8 pounds of muriate of potash and 16 pounds of boneblack superphosphate; and two plats remained unfertilized.

In the case of one of the experiments, the season was such as to prevent the drawing of conclusions. The statements following relate to the other experiment, which was made on the farm used for a similar experiment in 1889.

"The seeds from which the plants were secured were planted under glass, in February, 1890. Only strong and stocky plants were selected for the experiment. They were set 4 feet apart each way, with two rows on each plat, giving 136 plants per plat. The plats were laid out and the fertilizers applied May 9. The plants were set May 9, 10, and 13, beginning at the ends of the rows, and setting from side to side across the whole number of plats."

The yield of tomatoes at different pickings, the value of the crop, and the relation of yield and value of the early pickings to the total yield and value of the crop are tabulated for each plat.

Does nitrate of soda increase the yield at the expense of maturity?—The total yield and the total value of the crop were larger in every case where nitrate of soda was used. The yield and value of "early" tomatoes (picked between July 7 and August 5) were also larger where the nitrate was used, except in the two cases where 16 pounds of nitrate of soda was applied all at one time. In these two cases the average yield of early tomatoes was the same as that of the unfertilized plats. However, while the yield of early tomatoes was (with two exceptions) larger with nitrate of soda, the percentage of early tomatoes in the whole crop was lower with the nitrate than with barnyard manure or no fertilizer. The nitrate, therefore, "did not increase the maturity in the same ratio as the yield."

In the opinion of the author the results of this experiment "emphasize the general conclusions reached last year: (1) That nitrate of soda did not increase the yield at the expense of money value of early tomatoes when applied in small quantities [8 pounds per plat], or in large quantities [16 pounds per plat] in two applications. This was equally true for nitrate of soda both when used alone and when used in connection with phosphoric acid and potash. (2) That nitrate of soda did increase the yield at the expense of money value of early tomatoes, when large quantities were added in one application, in the presence of a sufficient excess of phosphoric acid and potash."

Influence of season on the effect of nitrate of soda.—It is stated that in 1890, while the yield of early tomatoes on the unfertilized plats was 89.4 per cent and their value 77.5 per cent higher than that of the preceding year, the yield of early pickings where nitrate of soda was used was only 53.8 per cent and their value 25.5 per cent greater than in 1889. Therefore, "while the relative effect of nitrate of soda is the same each year for the different quantities and methods of application, the actual effect on both yield and value of early tomatoes was much less in 1890 than in 1889."

For comparison, the yield and value of the total crop from each plat in 1889 and 1890 are tabulated.

[The table] shows that the average increase in total yield, due to nitrate manuring, was 297 baskets or 40 per cent in 1889, and 396 baskets or 42.1 per cent in 1890. In other words, the application of an average of 240 pounds of nitrate of soda per acre produced in 1889, 297 baskets of tomatoes, and in 1890, 396 baskets. The increased effect of an equal amount of nitrogen as nitrate in 1890 over 1889 was therefore equivalent to 99 baskets of tomatoes or 33.3 per cent. * * * The increased yield of 396 baskets or 42.1 per cent, in 1890 increased the value of the total crop but $106.08 or 29 per cent, while the increase in yield of 297 baskets or 40 per cent, in 1889 increased the value of the total crop by $119.96 or 46.2 per cent. It is clearly shown, therefore, that under the conditions which existed this year the nitrate of soda was more completely used by the crop than in 1889, but resulted in produce of lower value. These results are chiefly of interest in showing the influence of season, and do not change the general conclusion in regard to the value of nitrate of soda as a fertilizer for tomatoes.

Financial considerations.—"Properly used, the nitrate of soda is a profitable fertilizer for tomatoes." The net value (total value less cost of the fertilizers) of the crop on the unmanured plats in 1890 is given at $366.04 per acre. The highest net value per acre, $492.90, an increase of $126.86, was secured with the use of 160 pounds of nitrate of soda alone, applied in two separate portions.

The smallest net gains were secured from the use of barnyard manure; the largest from nitrate of soda alone. In three cases out of four, net gains were increased by two applications of nitrate of soda. In three cases out of four the 320 pounds of nitrate of soda per acre produce greater net gains than 160 pounds.

These conclusions are substantially identical with those secured from the study of yields, and show that financial profits from the use of nitrate of soda are also governed by the quantity applied, the method of application, and a full supply of mineral elements in the soil.

New Jersey Stations, Bulletin No. 80, March 14, 1891 (pp. 31).

EXPERIMENTS WITH FERTILIZERS ON POTATOES, E. B. VOORHEES, M. A. (pp. 3–24).—In order to ascertain the general practice followed in potato culture, the station sent out circulars "to about one hundred of the leading growers in the State," inquiring as to the crop and fertilizers usually preceding potatoes, the method of planting potatoes, variety used, kinds and amounts of fertilizers used, method of cultivation, average yield, and the average cost of labor expended on the crop.

The replies show a marked uniformity of practice, except in the amount of the plant food furnished by the manures used. The general practice may be stated as follows: Precede with a crop of corn treated with 10 or 12 tons of barnyard manure broadcast; prepare the ground thoroughly; cut the potatoes with one or two eyes and plant 4 to 5 inches deep in rows furrowed 3 feet apart, placing the pieces 12 to 15 inches apart in the row; broadcast barnyard manure at the rate of 10 to 20 loads per acre, and add chemical manures in the row at the rate of 300 to 600 pounds per acre; harrow before potatoes come up, and continue once or twice a week until plants are 3 inches high; then cultivate 3 or 4 times, or as often as possible until the vines have their growth. The leading varieties reported were, in their order, Early Rose, Silver Lake, Mammoth Pearl, Beauty of Hebron, and White Star. The yield reported ranged from 100 to 450 bushels per acre, 20 per cent of the number reporting more than 200 bushels, and but 6 per cent less than 150 bushels per acre. The cost of the crop, not including the manure or fertilizer, averaged $30 per acre.

A report is given of the first year's experiment carried on in 1890 at the college farm and two private farms, to compare the effects on potatoes of barnyard manure, "chemical manures," and a mixture of the two; of potash in the forms of sulphate, muriate, and kainit; and of nitrate of soda when applied all at once and in two portions at different times.

The soil of the college farm is described as "a gravelly, clay loam, with tight, red clay subsoil, and not especially adapted to potatoes. It had been in alfalfa since 1887, for which it was well manured. The soil of one of the private farms consisted of a medium sandy loam, with dry,

open subsoil, in a good state of fertility, and was well adapted to potatoes; that of the third farm was a light, sandy loam of rather medium fertility.

Each experiment was made on 14 twentieth-acre plats. Three of the plats received no fertilizers; on the remaining 11 plats 16 pounds of boneblack were combined, in separate cases, with 8 pounds of muriate or sulphate of potash, or 32 pounds of kainit per plat, and combinations of boneblack (16 pounds) with each of these different potash fertilizers were used with 10 pounds of nitrate of soda per plat, the latter being in some cases applied all at the time of planting and in others part at time of planting and part a month later; 1 ton of barnyard manure was used on one plat, and 1,000 pounds of barnyard manure, with half quantities of the mineral fertilizers, on another plat.

Early Rose potatoes were planted at the college and Burbank on the other two farms. The seed potatoes were cut to two eyes, and planted from 12 to 15 inches apart in rows 2½ feet apart. The potatoes were dug at the convenience of the farmers, and 5-pound samples taken from each plat for analysis. The yield of large and small potatoes and the total and net value of the crop at 75 cents per bushel for large and 40 cents per bushel for small potatoes, are tabulated for each plat in each experiment, and the average yields of the unfertilized plats, and of those receiving barnyard manure, mineral fertilizers, and a mixture of the two, are given for each separate experiment.

Relative effect of the different methods of fertilizing.—The following table shows the average results of plats receiving similar treatment at each farm:

Average results per acre of different methods of fertilizing.

	Cost of fertilizer.	Yield.	Value.	Net value.	Gain (+) or loss (—).
Farm No. 1 (college):		*Bushels.*			
Unfertilized	....	164.6	$113.73	$113.73	....
Barnyard manure	$30.00	203.6	142.20	112.20	—$1.53
Mineral fertilizers	11.19	158.9	110.38	99.19	—14.54
Mixture of manure and fertilizers	21.77	205.9	146.52	121.75	+11.02
Farm No. 2:					
Unfertilized	....	140.0	101.28	101.28	....
Barnyard manure	30.00	149.0	108.62	78.62	—22.66
Mineral fertilizers	11.19	175.2	129.34	118.15	+16.87
Mixture of manure and fertilizers	21.77	202.6	147.75	125.98	+24.70
Farm No. 3:					
Unfertilized	....	73.0	47.19	47.19	....
Barnyard manure	30.00	143.3	103.98	73.98	+26.79
Mineral fertilizers	11.19	143.6	101.52	90.33	+43.14
Mixture of manure and fertilizers	21.77	191.6	137.89	116.12	+68.93

"A study of the table shows that the application of 200 pounds of nitrogen, 200 of phosphoric acid, and 100 of potash in 20 tons of barnyard manure per acre, was followed by the lowest yield in all cases, and was profitable only on [farm No. 3]; that an average application of 20 pounds of nitrogen, 50 of phosphoric acid, and 80 of potash in the form of complete chemical manures was profitable on two farms; and that a combination of one half of the barnyard manure and one half of the

chemical manure used in the other methods gave the largest yield and was profitable in all cases."

Effect of the different forms of potash salts.—The yields with complete fertilizers, containing potash in the form of sulphate, muriate, or kainit, as tabulated, show that in each case the muriate gave a slightly increased yield (from 10 to 19 bushels per acre) over the sulphate. "The kainit was the least effective and in a few cases proved an injury."

Effects of nitrate of soda.—Nitrate of soda, applied all at time of planting or part at time of planting and the rest later, seems to have been practically without effect. "The reason for its failure to aid in the production of the crop is not clear, since the general experience of both experimenters and practical farmers is that uniformly good results have followed its use upon potatoes."

Chemical composition of the crop.—Analyses with reference to both food and fertilizing ingredients are given for samples of potatoes from each plat in each of the three separate trials.

The results from all the experiments agree very closely with each other, though a very marked difference is noticed in the effect of the different forms of potash. It has already been shown that manures, grouped either according to the form of potash or as a whole, did unfavorably influence the percentage of dry matter in the potato. Of the three forms of potash used, the sulphate was the least unfavorable, since it reduced the dry matter in the average of all the experiments but 0.68 pound in 100 pounds of potatoes or 3.1 per cent; and the kainit was the most unfavorable, and on the same basis reduced the dry matter by 2.59 pounds or 11.8 per cent; the effect of the muriate corresponded to the average general effect. It is also shown that the starch was affected by the different kinds of potash in the same relative proportion as the dry matter.

The teachings of these experiments do, therefore, accord with the opinions now generally held, and based upon previous experiments, namely, that potash does influence the composition of potatoes, and that of the different commercial forms the sulphate is the most valuable.

The author states further, that in general, while the potatoes on the plats receiving sulphate of potash were not as large, they were of more uniform size and of smoother skin than those on the plats fertilized with either muriate of potash, kainit, or barnyard manure. When cooked, the potatoes from the sulphate plats were believed to be of superior quality.

"As in the composition of food compounds, the variations in the amounts of plant-food elements contained were not marked in the samples from different plats in each experiment." The amount of fertilizing ingredients removed by the crop on each farm and the amounts left in the soil from the various applications, are calculated.

The chief points brought out by the experiments of this year are summarized as follows:

(1) The best results were secured when chemical manures were used in connection with barnyard manure.

(2) Kainit was less effective than either muriate or sulphate of potash; and sulphate of potash did not produce larger yields than muriate.

(3) Nitrate of soda did not prove a valuable fertilizer for potatoes.

(4) Potash does influence the composition of potatoes; and of the different commercial forms, the sulphate is the most valuable.

Though something has been learned from these experiments, further study seems imperative, for there is no one question so important to the general farmer of this State as the study of soils and crops in regard to the economical use of manures.

FIELD EXPERIMENTS WITH FERTILIZERS ON WHEAT, E. B. VOORHEES, M. A. (pp. 25–31).—These experiments, made on the land of a farmer in the State, were "planned to study the effects of nitrogen as nitrate of soda when used either alone or in connection with either one or both of the elements of potash and phosphoric acid."

The 5 tenth-acre plats used for the trial were used for an experiment with oats in 1889, and were fertilized for that crop as follows: Plats 1 and 5, unfertilized; plat 2, 150 pounds muriate of potash; plat 3, 300 pounds of "boneblack superphosphate," and plat 4, the two materials combined.

In the experiment with wheat, plat 1 received nitrate of soda 160 pounds per acre; plats 2 and 3, the same amount of nitrate with respectively 160 pounds of muriate of potash and 320 pounds of boneblack superphosphate; plat 4, the three materials combined; and plat 5 remained unmanured. One fourth of the nitrate of soda was applied at the time of seeding (September 24) and the remainder in the spring (April 29, 1890).

The yields of good and poor wheat and of straw, the weight of wheat per bushel, the analyses of the wheat and straw, and the amounts of fertilizing ingredients removed from the soil are tabulated for each plat. The following summary is taken from the bulletin:

Comparison of yields per acre.

	Wheat.	Straw.
	Bushels.	*Pounds.*
Unmanured land	12.7	1,555
Gain from nitrate of soda alone	5.8	925
Gain from nitrate of soda with potash	5.0	905
Gain from nitrate of soda with phosphoric acid	9.5	1,515
Gain from nitrate of soda with phosphoric acid and potash	12.6	1,585
Increased gain due to phosphoric acid	3.7	590
Increased gain due to phosphoric acid and potash	6.8	660

It will be observed that while the nitrate alone increased the yield by 5.8 bushels, its best effect, 12.6 bushels of wheat and 1,585 pounds of straw, or an increase of 100 per cent, was secured only when there was a full supply of the mineral elements. The presence of these influenced the quality of the product, as shown by the weight of measured bushel and by the amount of poor wheat.

Allowing $1.10 per bushel for the wheat and $5 per ton for the straw, the profit per acre is calculated to be as follows:

With nitrate of soda alone	$4.98
With nitrate of soda and potash	0.45
With nitrate of soda and phosphoric acid	6.42
With nitrate of soda, phosphoric acid, and potash	6.41

The author gives, in closing, directions as to the use of nitrate of soda on wheat.

New Mexico Station, First Annual Report, 1890 (pp. 8).

This contains a brief statement regarding the organization and equipment of the station, an outline of the experiments planned, and a financial statement for the fiscal year ending June 30, 1890. During 1890 the station published two bulletins, abstracts of which may be found in Experiment Station Record, vol. II, pp. 418, 419.

New York State Station, Bulletin No. 29 (New Series), April, 1891 (pp. 20).

FEEDING EXPERIMENTS WITH LAYING HENS, P. COLLIER, PH. D. (pp. 447–464).—The experiments made at the station in 1889, as to relative effects of rations containing different proportions of nitrogenous materials for laying hens, were continued in 1890. The experiment here reported extended from November 15, 1889, to November 15, 1890, and was made with four pens of fowls. The following rations were fed to fowls of both the smaller (single-combed White Leghorns, and white-crested Black Polish) and the larger breeds (Plymouth Rocks, Light Brahmas, and Buff Cochins):

Pen 5, 6 hens, smaller breeds....Oats, corn on the cob, and a mixture of linseed meal, bran, and ground oats.
Pen 6, 8 hens, larger breeds ....Nutritive ratio, 1.423 to 4.39.
Pen 7, 6 hens, smaller breeds.....Oats, corn on the cob, and corn meal.
Pen 8, 8 hens, larger breeds.....Nutritive ratio, 1.56 to 5.63.

Thus, while in addition to oats and corn on the cob, pens 5 and 6 received a grain mixture containing from 22.4 to 24 per cent of crude protein, pens 7 and 8 received corn meal containing 11.5 per cent of protein. All the fowls were given corn silage, red clover, and at times meat scraps.

"The fowls of contrasted pens were similar in regard to breed, age, and immediate parentage, and until 5 months old were under the same conditions of feeding, etc., but for the year preceding this trial were under rations of the same character for each pen respectively as those fed during this last period. The year for which the results are here given included the whole of the second laying season, all the fowls being mature, averaging about 17 months old when this experiment began."

The results are tabulated in detail for each pen. The average results per hen for the whole year are given as follows:

Average number and weight of eggs produced per fowl during one year and food consumed per day.

		No. of eggs.	Weight of eggs.	Total water-free food per day.
			Ounces.	*Ounces.*
Pen 5, smaller fowls	more nitrogenous ration	43.7	91.48	2.43
Pen 6, larger fowls	more nitrogenous ration	48.9	108.24	3.30
Pen 7, smaller fowls	corn-meal ration	68.7	136.29	2.57
Pen 8, larger fowls	corn-meal ration	50.1	112.16	3.27

Thus in the case of both the larger and the smaller breeds the number and weight of eggs were larger with the corn-meal ration than with the more nitrogenous mixture, this difference being greater with the smaller fowls. The fowls "having the corn-meal ration continued to lay for the longer period." In the previous experiment, while the smaller fowls produced more eggs with the corn-meal ration than with the more nitrogenous mixture, the results with the larger fowls were slightly in favor of the more nitrogenous ration.

The fowls having the more nitrogenous ration were always in better health, and their plumage, except during a short molting period, was always full and glossy, while those having the more carbonaceous ration were oftener sick and their plumage was always ragged and dull. For some time during the first year the vices of feather-pulling and egg eating were common among the latter. * * *

There is no doubt that during the laying period the fowls of both larger and smaller breeds receiving the corn meal, were fatter, for at nearly all times during this feeding trial the handling and weights of the birds indicated it.

At the close of the experiment the hens were all confined in small pens and given all they would eat of the same rations they had been receiving. After 6 weeks 19 of the 28 hens were killed and dissected. Data with regard to the live weight of the fowls, the weight of different parts of the body, and the relation of live weight to dressed weight, of lean meat to dressed weight, etc., are tabulated. The general average of the fowls killed showed the fowls receiving the more nitrogenous food to have become fatter than those receiving the corn-meal rations; but the author believes "there is no doubt that most of the fat was accumulated during this period of close confinement and heavy feeding without much exercise." The bones of those hens which had received the corn meal ration continually for 2 years "were, on the average, for each lot, heavier."

The number of eggs laid by the same hens during the second season "was but little less than that of the first season." Their average size was as follows:

	First year.	Second year.
	Ounces.	*Ounces.*
Smaller breeds, nitrogenous ration	1.85	2.09
Smaller breeds, carbonaceous ration	1.93	1.99
Larger breeds, nitrogenous ration	2.12	2.21
Larger breeds, carbonaceous ration	2.12	2.24

The cost of feeding hens entirely from the feed box for 4 months between the first and second laying season, is calculated at about 19 cents per fowl for the smaller breeds and 24 cents for the larger. "Unless pullets can be produced at less cost there would appear to be but little advantage in replacing hens for the first year, as is so often recommended, except where great difference in the market value of 1 and 2-year-old fowls exists."

General conclusions.

The results of several feeding experiments indicate that for laying fowls of smaller breeds Indian corn or corn meal can be fed in quite large proportion with a consid-

erable margin in its favor over certain more nitrogenous foods; but that while smaller fowls, even when confined, suffer little serious disadvantage under the ration, larger breeds will not endure for long periods a very large proportion of corn meal in their food, and unless at liberty, will do better with a somewhat more nitrogenous ration.

New York State Station, Bulletin No. 30 (New Series), May, 1891 (pp. 16).

CABBAGES AND CAULIFLOWERS, IMPORTED VS. AMERICAN SEED, P. COLLIER, PH. D. (pp. 465–470).—A report of tests made at the station in view of the fact that it has been claimed that better results may be obtained with the cauliflower and cabbage seed grown in this country, especially in the region of Puget Sound, Washington, than with imported seed. Details are given in five tables. In 1889 a test between Eastern and Puget Sound cauliflower seed resulted in favor of the latter. In 1890, imported. Long Island, and Puget Sound seed of both cabbages and cauliflowers were used.

The results seem to show that neither the Long Island nor the Puget Sound seed is in any way inferior to the imported seed. * * * The largest and heaviest seed made a quicker germination and a more vigorous growth immediately after being transplanted. These are both valuable considerations, as it often happens that a severe drouth or the attacks of the flea beetle cause the loss of a large number of plants in the seed bed or before they recover from the shock of transplanting. * * *

Only about half (58.46 per cent) of the early-planted cauliflowers developed heads, while 96.12 per cent of the late-planted reached maturity. In the case of the cabbages, 75.61 per cent of those planted early made marketable heads, although half of the varieties were those usually termed winter cabbages and seldom planted for summer use. The late planting of cabbages gave 96.34 per cent of marketable heads.

From a financial standpoint, however, the early planting gave more remunerative results.

TOMATOES, COMPARISON OF METHODS OF GROWING, P. COLLIER, PH. D. (pp. 471–478).—Tabulated data of yields and descriptive notes on the varieties compared are given for an experiment, which is described as follows:

In these tests 7 plants each of 19 of the newer varieties of tomatoes were used. The plants were set in a young vineyard that had been top-dressed with bone meal at the rate of 200 pounds per acre, the soil being in a good state of tilth. In setting the plants, each row was run east and west. A wire trellis was then run north and south, to which the eastern plant of each variety was trained. The next plant in each row was trimmed at frequent intervals, thus allowing the sunlight to penetrate to the soil and also reach every fruit. The 3 following plants were allowed to grow at will. The sixth plant was trained to a stake, being tied up as required, and the extreme western plant was trained to a wire trellis. The trimmed plants in almost every case gave the first ripe fruits, but both the west trellis and staked plants ripened 10 fruits as early as did the trimmed plants. Both the west trellis and staked plants of every variety yielded a very small crop. This is accounted for by the fact that there was a heavy clay knoll running through the vineyard. * * * During the fruiting season there was a very heavy rainfall. * * * In every case but one

the yield of ripe fruit was smaller than the yield of green fruit, making the yield of ripe tomatoes fall below the average. In this immediate vicinity the green fruit sold for about as much as the midsummer and late ripe ones, causing but little loss to the grower. It will also be noticed that the plants allowed to grow at will gave a larger yield per plant than any others, but the fruit was much later in ripening, in fact the greater portion of green fruits were picked from these plants.

The fruits on plants tied to trellis or stake were on an average of larger size and more symmetrical. For a small garden, either system will be found preferable to allowing the vines to grow at will, but in commercial growing the advantages are not enough to pay. The Chemin, Early Ruby, and Cleveland No. 115 proved the best of the early varieties. Matchless, McCulloms, and Cleveland No. 57 gave the largest yield.

TOMATOES FROM GREEN AND RIPE SEED, P. COLLIER, PH. D. (pp. 478–480).—Brief notes on experiments carried on during 8 years (1883–90). The results up to 1890, as summed up in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 598), indicated that the green seed would produce earlier and more numerous but smaller fruits, together with weaker vines.

The season of 1890 gave much the same results, the plants from immature seed ripening fruits 10 days in advance of those from mature seed; the growth of vines in 1890 was more vigorous than in previous years and the fruits larger. This was probably due to the fact that the specimen fruit selected for seed in 1889 was of large size, and while very green had nearly obtained its maximum development. * * * It is yet a question of how much further towards a perfectly ripe fruit it will be best to go to procure seed that will give more vigor of plant and still retain the early-ripening qualities of immature seed.

Oregon Station, First and Second Annual Reports, 1889 and 1890 (pp. 13 and 18).

These include financial statements for the years ending June 30, 1889 and 1890, the regulations of the board of regents of the State Agricultural College for the government of the station, brief outlines of the work, and a synopsis of Bulletins Nos. 1–7 of the station.

South Dakota Station, Bulletin No. 24, May, 1891 (pp. 15).

EXPERIMENTS WITH CORN, L. FOSTER, M. S. A. (pp. 152–164).—A brief account of the results of experiments with varieties of corn and on the time and thickness of planting and methods of cultivation, carried on at the station during 3 years (1888–90). A previous report on this series of experiments was published in Bulletin No. 9 of the station (see Experiment Station Record, vol. I, p. 18). The original purpose of the experiments was to find out whether corn could be successfully grown in this section. Tabulated and descriptive notes are given on 14 flint and 7 dent varieties which have proven best adapted to the part of South Dakota in which the station is located. The experiments thus far made indicate that, (1) the best time for planting in this locality is between May 10 and 20, and (2) that the season of

growth before injurious frosts is about 100 days from May 15. Experiments in 1890 with different distances of planting in hills and drills and with deep and shallow cultivation, are briefly recorded.

Tennessee Station, Bulletin Vol. III, No. 6, December, 1890 (pp. 14).

This contains an index to vols. I, II, and III of the bulletins of the station.

Tennessee Station, Bulletin Vol. IV, No. 1, January, 1891 (pp. 54).

CRAB-GRASS HAY, C. W. DABNEY, JR., PH. D. (pp. 4–8, fig. 1).—Brief descriptive notes on crab grass (*Panicum sanguinale*), with tabulated results of analysis of this and other plants. In a brief introduction to the bulletin the director of the station makes the following statement regarding this plant:

> Throughout the Northern and Middle States crab grass, or finger grass as it is sometimes called, is regarded only in the light of a weed and a pest. In this State, while often playing the part of a weed (and a very persistent one too) in gardens and hoed crops, crab grass under certain conditions becomes of much value both for summer pasturage and for hay. It springs up in corn and grain fields after these crops are harvested, and frequently yields a large amount of hay, which though bulky, is, as determined by the chemist, more nutritious, weight for weight, than timothy.

The results of analyses made at the station and elsewhere are reported in the following table:

Composition of various kinds of hay and grass.

	Moisture.	In 100 parts of dry matter there are—							
		Protein or albuminoids.	Ether extract or fats.	Nitrogen-free extract or carbohydrates.	Crude fiber.	Crude ash.	Total nitrogen.	Albuminoid nitrogen.	Nutritive ratio.
Andropogon argyraeus	8.40	4.25	2.00	58.83	31.06	3.02	0.68	0.66	1 to 15.0
Tall redtop	8.71	6.62	2.45	54.85	31.56	4.52	1.06	1.00	1 to 9.2
Timothy hay*	.... .	8.62	3.02	40.34	33.92	5.10	1.38	1.21	1 to 6.4
Orchard-grass hay*	13.64	9.62	3.85	38.04	41.97	6.52	1.56	1.29	1 to 4.9
Crab-grass hay, ours, 1889	5.98	9.25	2.93	45.84	27.16	8.82	1.48	(‡)	1 to 5.7
Crab grass hay, ours, 1890	5.87	10.12	3.68	53.06	26.82	7.32	1.62	1.33	1 to 6.0
Mature crab grass,† C. Richardson	14.30	9.78	2.82	42.70	32.09	12.61	1.57	1.06	1 to 5.0
Crab grass† cut June 23, C. Richardson	76.50	23.13	4.84	37.99	19.03	15.01	3.70	(‡)	1 to 2.1

*New York State Station Annual Report for 1888.

† U. S. Department of Agriculture, Division of Botany, Special Bulletin on Grasses and Forage Plants.

‡ Not determined.

SORGHUM AS A FORAGE PLANT, P. F. KEFAUVER (pp. 9–14).—Compiled notes on the advantages of sorghum as a forage plant, with brief accounts of experiments by the author in raising this crop and feeding it to animals. In the case of dairy cows it was found to be desirable to combine cotton seed or cotton-seed meal with the sorghum in order to keep up the yield of butter.

Test of feeding value of first and second crops of clover, C. S. Plumb, B. S. (pp. 15–20).—The following experiment to compare the feeding value of first and second crops of clover hay in fattening steers was made during the winter of 1889–90. Four grade Shorthorn steers about 2 years old were divided into two equal lots, and fed rations containing either first or second cuttings of clover, with wheat bran and corn meal, during 14 periods of 10 days each. The animals were fed alternately on the two rations, lot 1 receiving first-crop clover, while lot 2 received second-crop clover, and *vice versa*. Cut wheat straw was fed to some extent with the second-crop clover. The composition of the clover and straw is given as follows:

Composition of first and second-crop clover and wheat straw.

[Averages for two analyses made at different periods.]

	Clover. First crop.	Clover. Second crop.	Wheat straw.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8.91	8.29	5.57
Crude ash	7.69	7.13	4.33
Crude cellulose	23.05	31.28	38.54
Crude fat	3.34	2.26	1.61
Crude protein	12.94	13.12	13.50
Nitrogen-free extract	44.07	37.92	46.45
	100.00	100.00	100.00

The first-crop clover "was well eaten," but the second-crop clover "was eaten reluctantly, and its use was accompanied with more or less salivation." The food consumed and the gain in live weight of the four animals while on each ration are calculated as follows:

Food consumed and live weight gained by four steers.

	Clover.	Straw.	Bran.	Corn meal.	Gain in live weight.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
First crop	3,401.50	....	1,010.00	2,020.00	638
Second crop	1,059.25	1,076.75	1,008.50	2,316.50	100

"According to these figures, it required of first crop of clover and grain 10 pounds of food to 1 pound of gain. It required of second crop of clover and grain 54.6 pounds of food to 1 pound of gain."

Pasture grasses, F. L. Scribner, B. S. (pp. 21–25, plates 3).—Descriptive notes on Texas blue grass (*Poa arachnifera*), velvet grass (*Holcus lanatus*), and Tennessee fescue or glaucous creeping fescue (*Festuca rubra*, var. *glaucescens*). Of the three plates with which the article is illustrated, two are from Beal's Grasses of North America, but the third is original. Tennessee fescue is the name given by the author

to a variety of *Festuca rubra*, first discovered by Dr. A. Gattinger "growing on the limestone cliffs along the Cumberland River near Nashville, in 1867." As far as known it has not been observed outside the limits of Tennessee.

It is a near relative of the red or creeping fescue of Europe, and like that, has a creeping or stoloniferous root. It is therefore an excellent turf-forming grass, with good staying qualities, and will doubtless withstand well the tramping of stock. In our latitude it remains green the year round, being little affected by drouth or the severe cold of winter, and its great mass of fine root leaves will yield rich grazing wherever it is allowed to become well established. Its flowering stems grow to the height of 2 feet or more; it blossoms in May, maturing its seed in July. It is to be recommended only for pastures, but there, especially upon worn-out soils and hill slopes, we are confident that it will prove of great value.

Tests of this grass will be made at the station.

BLACK KNOT OF THE PLUM AND CHERRY, F. L. SCRIBNER, B. S. (pp. 26–28, plate 1).—Descriptive notes on *Plowrightia morbosa*, with suggestions as to remedies. The illustrations are from *Orchard and Garden*, and after Farlow.

PRUNING FRUIT TREES, R. L. WATTS, B. AGR. (pp. 29–31).—General instructions regarding the pruning of fruit trees.

GLASSY-WINGED SOLDIER BUG, H. E. SUMMERS, B. S. (pp. 32, 33, figs. 2).—Descriptive notes on *Hyaliodes vitripennis*, Say, which preys upon the grapevine leaf hoppers.

DISEASES OF LIVE STOCK, W. B. NILES, D. V. M. (pp. 34–36).—In view of the fact that a disease resembling "staggers" was causing serious injury to horses, mules, and cattle in Tennessee, Dr. Niles of the University of South Carolina, was sent for to make an investigation of the trouble. In this article he states that he was convinced that "the disease affecting horses and mules is the same as the disease called 'staggers' in Virginia, North Carolina, South Carolina, and some other States. The disease affecting cattle appears to be a different trouble, and is very probably the same as the trouble which annually appears in some of the Northwestern States, and which is by some called the 'cornstalk' disease."

The probable causes of these diseases are discussed and suggestions are made regarding treatment.

EXPERIMENT STATION RECORD (pp. 37–54).—Abstracts of bulletins Vols. I, II, and III, taken for the most part from Experiment Station Bulletin, No. 2, part I, and Experiment Station Record, vols. I and II, of this Office.

Tennessee Station, Bulletin Vol. IV, No. 2, April, 1891 (pp. 21).

PEANUT CROP OF TENNESSEE, STATISTICS, CULTURE AND CHEMISTRY, L. P. BROWN (pp. 55–73).—"Tennessee's crop of peanuts for the year 1889 was not far from 550,000 bushels, worth, at a low estimate, 90 cents per bushel, a total value of $495,000. The total crop of the United States in 1889 was probably about 2,700,000 bushels. In 1890

the crop was much larger." It costs about 40 cents per bushel to grow peanuts in Tennessee, and the average price to the producer is from 95 cents to $1.05. The average crop is from 40 to 60 bushels per acre, and the money return is from $22 to $40 per acre. In Tennessee peanut growing is mainly confined to six or seven counties in the center of the State. The soil used is sandy or gravelly clay, with a clay subsoil, and is derived from siliceous limestones and sandstones.

Two kinds of peanuts are grown in Tennessee, viz, white and red. The white variety is produced in much the larger quantity, as they bring about 25 cents per bushel more than the red. The red nut is so called from the color of the skin of the kernel. The white nut has a skin nearly or quite white, but which darkens with age. The white nut has a more spreading habit of growth than the red, is said to be more prolific, and is later in coming to maturity. The red matures better because earlier, and yields fewer imperfect pods, called "puffs" or "pops."

Tabulated results of analyses by the author of different parts of the peanut plant, are given and compared with the analyses made elsewhere of this and other crops. The original analyses reported in this article are as follows:

Composition of peanuts grown in Tennessee.

	Moisture.	In 100 parts of dry matter there are—				
		Protein or albuminoids.	Ether extract or fats.	Nitrogen—free extract or carbohydrates.	Crude fiber.	Crude ash.
Kernel of peanuts:						
Crop, 1888	3.87	28.65	49.35	17.23	2.37	2.40
Crop, 1889	4.86	27.07	48.60	19.30	2.52	2.51
Peanut meal	10.64	49.63	6.33	31.67	6.06	6.31
Peanut hulls	8.81	6.42	1.34	17.14	73 07	2.03
	7.81	7.94	2.17	13.36	65.81	3.63
Peanut hay	7.83	11.75	1.84	46.95	22.11	17.04

Ash analyses of peanuts.

	In 100 parts of dry ash there are—						
	Phosphoric acid. P_2O_5	Potash K_2O	Soda Na_2O	Lime CaO	Magnesia MgO	Sulphuric acid. SO_3	Silica.
Kernels of peanuts	38.90	39.85	2.85	4.11	1.83	10.40	0 20
Hulls of peanuts	5.63	31.78	7.85	27.01	12.60	8.89	4.13
Leaves of peanut vines	4.85	15.00	7.26	50.77	10.89	3.57	5.60
Stems of peanut vines	5.34	19.23	7.52	25.80	19.67	7.42	9.93

Summary.—(1) The best results in peanut growing are to be obtained only by careful attention to details, such as selection and preservation of seed, careful preparation of the ground, care in selecting seed, and good culture of the peas. Only in this way can the planter always be sure of getting just returns for his labor, no matter what the prices are.

(2) The peanut is one of the richest vegetable foods known. Peanut meal is fully equal to cotton-seed meal as a feeding stuff. It is, however, hardly known in this country for this use.

(3) Until some other use is found for them, the hulls, which accumulate in considerable quantities at the recleaners, are practically a waste product, as they have only a small fertilizing value and are not used as a fodder.

(4) The practice of feeding the hay is one long established, and for this purpose it seems to be about equal to clover hay, especially for cattle.

(5) Experience in Virginia and North Carolina seems to indicate that a moderate use of commercial and home-made fertilizers would pay growers of peanuts in Tennessee. From the analyses and from what we know of the needs of similar plants, it is suggested that experiments be made with home-mixed fertilizers giving 15 pounds of nitrogen, 10 pounds of available phosphoric acid, and 20 pounds of potash per acre.

West Virginia Station, Third Annual Report, 1890 (pp. 190).

REPORT OF DIRECTOR, J. A. MYERS, PH. D. (pp. 4–29, plates 4).—This includes the text of the acts of Congress and of the State legislature relating to the station, and a financial statement for the fiscal years ending June 30, 1889 and 1890; a description of the station building and its equipment, with ground plans and a view of the exterior; and brief statements regarding the work of the station.

THE CREAMERY INDUSTRY (pp. 29–88, plates 3, figs. 6).—In this article the author points out the more important factors essential to success in butter making, mentions the different devices for raising cream by setting, gives the history of the development of the centrifugal apparatus so largely used in one form or another in creameries, describes its manner of working, and illustrates and describes several of the different forms. The article also contains tabulated data and summaries of observations on the separation and churning of cream for each month from November, 1889, to June, 1890, inclusive; analyses of sweet-cream butter; a description of the method of butter analysis; the results of churn tests of milk; and full descriptions of the Short, Patrick, Cochran, Babcock, and Beimling (Vermont Station) methods of determining the amount of butter fat in milk, the apparatus used in all except the first being illustrated by cuts.

"The average of the churnings of acid cream and sweet cream for the period beginning November 1, 1889, and closing June 30, 1890, show that it required 3.95 pounds of acid cream to make one pound of butter, and 3.74 pounds of sweet cream to make one pound of butter."

In the churn test made for 9 days to study the reliability of this method of determining the amount of butter which may be separated from cream, "in five cases out of nine the overchurning of the cream gave an average of 6.36 ounces more of butter per hundred pounds of milk than did churning the cream to the granulated condition. In four cases out of nine tests the overchurning of the cream gave an average excess of 3.32 ounces per hundred pounds of milk in favor of churning to the granulated condition."

Suggestions are made as to the execution of the various quick methods of determining fat in milk, with a table, prepared by B. H. Hite, for

converting the degrees of the Beimling test to per cent of fat. The results of comparative determinations of the fat in samples of cream, whole milk, buttermilk, and skim milk by the Beimling, Babcock, Cochran, and Soxhlet methods, and the Adams gravimetric method are also stated. Comparing the Beimling and Babcock methods, the former "gives somewhat higher results in our hands than does the Babcock process and is more rapid." The results by the Beimling "compare very favorably with the results by the Adams method," and "taking it all in all, we hold this method of analysis of milk in very high esteem." The results by the Babcock method, "while very uniform among themselves, ran appreciably lower than analyses made by the Adams method." This was especially true in the case of skim milk or buttermilk.

In the limited number of comparisons of the Cochran and Soxhlet methods with the Adams, the results varied from those by the Adams method by 0.2 per cent or over in about half the cases, the difference being in several cases over 0.4 per cent of fat.

REPORT OF BOTANIST AND MICROSCOPIST, C. F. MILLSPAUGH, M. D. (pp. 89–144, plates 4, figs. 17).—This includes brief statements regarding the flora of West Virginia; notes on a tour of observation in the State made by the author in the summer of 1890; brief descriptive notes on sixty species of trees and shrubs growing on the campus of West Virginia University; a list of the native trees and shrubs of the State; a brief account of an experiment begun in 1890 with several varieties of Austrian basket osiers; notes on the Canada thistle (*Cnicus arvensis*), which were also published in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 745); and a somewhat detailed account of the processes and apparatus of photography in its application to station work. The report is illustrated with a map of West Virginia, two plates showing the Canada thistle at different stages of its growth, and numerous cuts exhibiting different pieces of photographic apparatus.

The boundary line of West Virginia has become a synonym for irregularity, the truth of which a glance at the map accompanying this report will show. The topography of the State might be comprised also, suggesting as it does an immense field over which a gigantic plow, drawn by a powerful griffin, which, goaded into frenzy with the trident of its Plutonic follower, had left in its erratic leaps and flights a confused maze of deep and irregular furrows. This topographical condition is mainly due to the great number of rapid-flowing streams, which, rising in the higher mountain ranges of the eastern and southern borders, pass in varied courses through the State to augment the Ohio west and northwest and the Potomac in the northeast.

Among the low as well as the loftier mountain ranges, there is comparatively little table-land; and in the valleys a like absence of extensive bottoms, except along Tygart's Valley River in Randolph County, the Great Kanawha, and the Ohio. The absence of ponds and lakes is remarkable, not one to my knowledge existing within the boundaries of the State.

The predominating soil of the hills and valleys is clayey and sandy alluvium, stiff clay, and loam, with some calcareous matter admixed in certain sections. The rocks

are principally sandstone, limestone, and shale. The special features of the now very fertile and then quite sterile soils compounded of the above deposits and rocks, we need not enter into in this place; suffice it to say that our soils give us a varied flora, and one often widely different in localities only a few miles apart. * * *

With the exception of a few transient botanists who have worked over, for their own personal pleasure, the neighborhood of some vacation resort in the State, the only attempts at obtaining a knowledge of the vegetable resources of the State may be summarized as follows:

1867 and 1871. Dr. A. S. Todd, as chairman of a committee of the Medical Society of West Virginia, published a list of the medicinal plants of West Virginia. This list contains an enumeration of 9 trees, 7 shrubs, and 60 herbs.

1870. Mr. DissDebarr, State commissioner of immigration, in his Handbook of West Virginia, compiled a list of the timber trees of the State, in which he enumerated 52 species and added 12 species of shrubs.

1876. Professor Fontaine in compiling his portion of the centennial volume upon the Resources of West Virginia, listed more carefully the forest trees, shrubs, and medicinal plants of the State, drawing the last from the publication of Dr. Todd. This work contains an enumeration of 69 trees and 16 shrubs.

1878. Profs. H. N. Mertz and G. Guttenberg published a check list of the flora of West Virginia, being an account of work done along the upper Ohio bottoms, and in the mountains of the northeastern portion of the State, the latter while located at Harper's Ferry. This list enumerates 59 trees, 37 shrubs, and 494 herbs.

Miss Verona Mapel, preceptress of the high school at Glenville, Gilmer County, has quite thoroughly worked over her immediate vicinity in connection with her school duties. She reports 42 trees, 23 shrubs, and 290 herbs. Her list does not include the commoner weeds and herbs, nor the grasses or sedges.

Judge Frank A. Guthrie, of Point Pleasant, at the mouth of the Great Kanawha River, has carefully worked his vicinity, which includes the bottom lands of the Ohio and Kanawha Rivers and the adjacent ridges.

REPORT OF ENTOMOLOGIST, A. D. HOPKINS (pp. 145–180, plates 2).—This includes notes on a number of species of farm and garden insects and a preliminary report on investigations of forest and shade-tree insects.

Farm and garden insects (pp. 147–163).—Notes are given on the following insects, including accounts of life history, observations by the author, and statements regarding experiments with insecticides: Striped flea beetle (*Phyllotreta vittata*), sheep tick (*Melophagus ovinus*), plum curculio (*Conotrachelus nenuphar*), codling moth (*Carpocapsa pomonella*), imported currant worm (*Nematus ventricosus*), house fly (*Musca domestica*), Colorado potato beetle (*Doryphora 10-lineata*), currant worm (*Pristiphora grossulariæ*), white grub (*Lachnosterna fusca*), wireworms, cabbage worm (*Pieris rapæ*), cabbage pionea (*Pionea rimosalis*), apple tree tent caterpillar (*Clisiocampa americana*), stock borer, grain plant louse (*Siphonophora avenæ*), peach tree borer (*Ægeria exitiosa*), apple tree borer, horn fly, and raspberry gouty gall beetle (*Agrilus ruficollis*). The account of the raspberry beetle is accompanied by a plate containing nine original figures. Two parasites were discovered by the author on the larvæ of this insect, which were determined at this Department to be, respectively, a new species of *Bracon* and *Charitopus magnificus*.

Forest and shade-tree insects (pp. 164–180).—An account is given of observations by the author in August, 1890, on locust trees in the vicinity of the station, which were seriously injured by the ravages of insect pests.

The region thus affected, so far as I have since observed, extends through Doddridge, Harrison, and Preston Counties, from Grafton westward to near the Wetzel County line, from Fairmont through Monongalia County to the Pennsylvania line, and from Piedmont southward through Tucker, Randolph, Upshur, and Lewis Counties. The trees are unaffected through Ritchie and Wood Counties and along the Ohio River, as far as was observed, the leaves being fresh and green at the time they seemed to be dying in the infested districts mentioned. This dead and scorched appearance of the locust trees at a time of year when they are noted for their beautiful green foliage, was, as far as can at present be learned, first noticed in Harrison County about the year 1885, when a few scattering trees were observed to turn brown. The number of trees thus affected rapidly increased each year until every tree, bush, and sprout of this species looked as if it had been killed by fire. This trouble continued to spread until at present at least one fifth of the State is affected.

While over forty species of insects were found to be feeding on different parts of the affected trees, one species, the locust hispa, appeared to be the principal cause of the trouble.

Notes are given on the locust hispa (*Odontota dorsalis*), *O. nervosa*, locust borer (*Cyllene* [*Clytus*] *robiniæ*), locust tree carpenter moth (*Xyleutes robiniæ*), locust sprout and twig borer, yellow locust midge (*Cecidomyia robiniæ*), six undetermined species of leaf miners, locust-skipper butterfly (*Eudamus tityrus*), and seven undetermined species of locust leaf rollers and pasters. A plate containing nine figures illustrates the article.

An account is also given of observations by the author and of information derived from other sources, regarding the causes of the death of large tracts of black spruce (*Picea mariana*) timber in West Virginia. The following summary is taken from the report:

The spruce forests of West Virginia are estimated to exceed 500,000 acres.

Isolated portions in these forests are dead, possibly to the amount of 150,000 acres.

While conducting an investigation in one of these affected portions [Cheat Mountain region] the author observed that all of the characteristic dead trees there bore abundant evidence of the attack of insects belonging to the family Scolytidæ.

A number of small trees were found partly dead and dying, near where trees had been cut last summer.

Great numbers of bark and timber beetles were found in the bark and sap wood of these dying trees both in the green and dead portions.

Three species of parasites (*Trigonoderus*, *Helorus*, and *Spintherus*, n. sp.) of these beetles were plentiful, and were noticed flying around and on the bark of the infested trees. Some of them were observed with their ovipositors inserted into the bark, while others were entering and emerging from the burrows made by the beetles. Here evidence was obtained of the possibility of these beetles being destroyed or reduced by natural means to such an extent that they could no longer be destructive to trees.

These same beetles were found to be very plentiful in the logs, stumps, and tops of last summer's cuttings near these dying trees.

There was very little evidence of the attack of these beetles on the stumps and tops of the 1887 cuttings, indicating that at or near the time the timber ceased dying in this locality these insects were not plentiful.

The conclusion arrived at from personal observation and notes leads me to believe that the death of the trees is probably due to the combined effect of two causes:

(1) The ravages of the insects primarily succeeded some injury to probably a few trees in isolated localities.

(2) When the conditions were no longer favorable to their existence in the injured trees, and they had increased to great numbers, the possibility of their attacking the healthy trees from sheer necessity and continuing to spread until checked by some natural cause, seems to me evident. I reach this conclusion from the fact that I have found these same scolytids working in the green, sappy wood and bark.

Still further investigations will be made in the spruce forests of the State in this and other localities, and a final report will appear in a future bulletin. This bulletin will also contain a list of all insects taken in these forests, and such other additional facts as may be determined.

REPORT OF AGRICULTURIST, D. D. JOHNSON, M. A. (pp. 181–185).—Brief statements regarding the plan on which the station conducts coöperative experiments with farmers, and the farmers' institutes carried on under the auspices of the station.

Wisconsin Station, Bulletin No. 27, April, 1891 (pp. 13).

THE FEEDING VALUE OF WHEY, W. A. HENRY, B. AGR.—"One hundred pounds of average milk contain about 13 parts of solids. In the process of butter making most of the fat is removed by skimming, leaving nearly all of the other solids. In cheese making the casein is coagulated by rennet so that nearly all of it is recovered. Most of the fat goes with the casein also. The albumen, a valuable food product, is not coagulated by the rennet, but remains in the whey, as does most of the ash." The constituents of 100 pounds of average milk, and of the buttermilk and skim milk, or the whey from the same, are calculated as follows:

Ingredients of 100 pounds of whole milk and the by-products from the same.

	Casein.	Albumen.	Fat.	Sugar.	Ash.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
One hundred pounds of average full milk contain about.	3.5	0.7	3.5	4.5	0.7
The skim milk and buttermilk together from the above 100 pounds would contain about	3.4	0.7	0.3	4.4	0.7
The whey from the above 100 pounds would contain about.	0.1	0.7	0.4	4.3	0.6

Four feeding trials were made with pigs during the fall and winter of 1890–91 to ascertain the value of sweet whey for pigs, and the most advantageous manner of feeding it. "In each trial one lot of pigs received grain only. This consisted in one instance of corn meal and shorts, half and half; in the others, of two thirds shorts to one third corn meal. Three pounds of water were mixed with each pound of the grain ration to form a slop; in the other cases, whey in varying proportions was fed mixed with the meal to form a slop. In all cases the whey was fed sweet."

The first trial was with 12 pigs, from 5 to 5½ months old at the beginning of the trial, and lasted from November 17 to December 22. The grain mixture consisted of equal parts of corn meal and shorts. The four lots of 3 pigs each received the following rations: Lot I, grain mixture and water; lot II, 2 pounds of whey to 1 pound of grain mixture; lot III, 9 pounds of whey to 1 pound of grain mixture; and lot IV, 10 pounds of whey to 1 pound of shorts.

The second and third trials extended from February 23 to March 30. The same pigs were used in the second trial as had been used in the first, but the division into four lots was such as to form new groups. Sixteen pigs, about 6 months old, were used in the third trial, and were divided into four lots. The grain mixture in both trials consisted of one part by weight of corn meal to two of either shorts or middlings The several lots in both trials were fed as follows: Lots I, grain mixture and water; lots II, 3 pounds of whey to 1 pound of grain mixture; lots III, 6 pounds of whey to 1 pound of grain mixture; and lots IV, 10 pounds of whey to 1 pound of grain mixture.

In the fourth trial, 6 pigs, about 9 months old, were divided into two equal lots, and fed from March 2 to March 30, as follows: Lot I, grain mixture, consisting of equal weight parts of corn meal and shorts, and water; and lot II, 6 pounds of whey to 1 pound of the same grain mixture.

For at least one week previous to the beginning of each trial the pigs were fed the same rations that they were to receive during the trial. Tabulated data showing the food consumed and gain in live weight by each pig are given for each trial, together with a general summary of the four trials by lots. The general summary of the results of the four trials is as follows:

Summary of four trials.

	Food consumed.		Total gain in live weight.	Food for 100 pounds gain.		Grain saved by whey.	Whey substituted for 100 pounds of grain mixture.
	Grain mixture.	Whey.		Grain mixture.	Whey.		
First trial: Average weight of 12 animals, 127 pounds.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Lot I	486	....	105	463	....	....	....
II	504	1,038	154	327	687	136	505
III	300.5	2,124	117	257	1,815	206	881
IV	215.5	2,226	119	181	1,871	282	663
Second trial: Average weight of 12 animals, 240 pounds.							
Lot I	627.5	....	101	621	....	....	....
II	627.5	1,856	161	390	1,153	231	499
III	453	2,676	124	365	2,158	256	843
IV	347.5	3,459	132	263	2,620	358	732
Third trial: Average weight of 16 animals, 140 pounds.							
Lot I	632.5	....	130	486	....	....	....
II	632.5	1,871	170	372	1,100	114	964
III	454	2,710	157	289	1,726	197	876
IV	352.5	3,509	152	232	2,309	254	909
Fourth trial: Average weight of 6 animals, 323 pounds.							
Lot I	543	....	85	639	....	....	....
II	394.5	2,297	111	355	2,069	284	728

"The average of the ten lots shows that 760 pounds of whey effected a saving of 100 pounds of the corn meal and shorts mixture by partial substitution. * * * The tables seem to show that the whey has increased the availability of the ration by more than the solids added to it in the whey."

Reference is made to experiments by Fjord,* in which 1,200 pounds of whey left in the manufacture of cheese from centrifugal skim milk were equivalent to 100 pounds of barley or rye meal, when fed as a partial substitute for the latter.

The author gives the following conclusions from his experiments:

(1) We were not successful in maintaining pigs on whey alone.

(2) Pigs fed on corn meal and shorts with water required 552 pounds of the mixture for 100 pounds of gain.

(3) When whey was added to the corn meal and shorts mixture it produced a marked saving in the amount of grain required for good gains. This was true for mixtures varying from 2 pounds of whey to 1 of grain up to 10 pounds of whey to 1 of grain.

(4) It was found when using whey as a partial substitute for grain that 760 pounds of whey effected a saving of 100 pounds of the corn meal and shorts mixture.

(5) Using these figures, if corn meal and shorts are valued at $12 per ton, then whey is worth 8 cents per hundred pounds; at $15 per ton for the corn meal and shorts, whey would be worth 10 cents per hundredweight.

(6) Shorts, pea meal, and oil meal or like feeds should be mixed with whey for growing animals. Some corn may be fed at all times, the proportion increasing as the animal approaches maturity.

Wyoming Station, Bulletin No. 1, May, 1891 (pp. 24).

ORGANIZATION OF THE STATION, D. MCLAREN, M. S. (pp. 3-6).— The station was established as a department of the University of Wyoming by an act of the State legislature, approved January 10, 1891. The present Director was elected March 27, 1891.

In order that the possibilities of agriculture in all parts and altitudes of Wyoming may be fairly tested, the trustees have established experiment farms in various portions of the State. The west central portion and the altitude of 5,500 feet above sea level is represented by the Lander experiment farm of 137 acres, under irrigation, in Fremont County, and donated by its citizens. The Laramie Plains and the altitude of 7,000 feet is represented by the Wyoming University experiment farm of 640 acres in Albany County, irrigated from the Pioneer Canal, and granted by the Wyoming Central Land and Improvement Company. The North Platte Valley and the altitude of 6,000 feet is represented by the Saratoga experiment farm of 40 acres, under the Hugus-Mullison-Beale Ditch and the Davis-Folsom Canal, in Carbon County, donated by the Saratoga Improvement Company and the Saratoga Land and Irrigation Company. The northern part of the State and the altitude of 4,000 feet is represented by the Sheridan experiment farm of 50 acres, under irrigation, in Sheridan County, and donated by its citizens. Northeastern Wyoming, with the greatest rainfall and the altitude of 4,500 feet, is represented by the Sundance experiment farm of 49 acres, to be carried on without irrigation, in Crook County, and donated by its citizens. Southeastern Wyoming, the Sybille Valley, and the altitude of 5,000 feet, is represented by the Wheatland experiment farm, under Ditch No. 2, of the Wyoming Development Company, in Laramie County, being donated by that company.

FARM WORK IN PROGRESS, D. MCLAREN, M. S. (pp. 6–9).

To facilitate the planting and measurement of crops and the keeping of accurate records, a forty-acre tract on each of the experiment farms has been divided into 36 one-acre plats, separated by crossroads, which, with the surrounding road, occupy the other 4 acres. These 36 one-acre plats have the same numbers and subdivisions as the 36 sections in a United States Government township.

Each of the forty-acre tracts has been plowed, and fenced with barbed-wire. The staple crops in many varieties have been planted on each. On the Wyoming University experiment farm at Laramie 6 acres are planted with cereals, 1 acre with potatoes, 1 with field peas, 1 with sugar beets, 1 with sorghum and corn, 1 with turnips and carrots, and 5 with grasses and forage plants, all in many varieties, for tests and for distribution among the farmers of Wyoming. Similar crops are planted on each of the experiment farms. At the Lander experiment farm, fruit and forest trees are planted. Aërial irrigation will be tested on the Saratoga experiment farm. At the Sheridan, Sundance, and Wheatland experiment farms extensive trials of field corn are being made. The crops on the Sundance experiment farm will not be irrigated, as that region receives the greatest rainfall.

In coöperation with the Department, the station has undertaken experiments with grass and forage plants grown without irrigation The aim is to find species of grass or methods of treatment that will benefit the large tracts of grazing land in the State which are difficult to irrigate. They are conducted on 10 acres of land near the station, which represent the average soil and climate of the Laramie Plains. The following species have been planted:

Northern blue grass (*Poa nemoralis*), orchard grass (*Dactylis glomerata*), switch grass (*Panicum virgatum*), Northern hair grass (*Aira cæspitosa*), scarlet clover (*Trifolium incarnatum*), alsike clover (*T. hybridum*), alfalfa (*Medicago sativa*), white sweet clover (*Melilotus alba*), esparcet or sainfoin (*Onobrychis sativa*), Northern lupine (*Hedysarum coronarium*), land clover (*Anthyllis vulneraria*), *Galega officinalis*, burnet (*Poterium Sanguisorba*), Indian millet (*Panicum miliaceum*), rescue grass (*Bromus schraderi*), wild chess (*B. inermis*), tall fescue (*Festuca elatior*), rye grass (*Lolium perenne*), canary grass (*Phalaris arundinacea*), Guinea corn (*Sorghum vulgare*, var. *cernuum*).

"For comparison and test 3 acres of prairie on the Wyoming University experiment farm are sowed with the same grasses, and will be irrigated. Five other acres of prairie will be flooded to test the effect of irrigation on the natural grass." Experiments will be tried with reference to the retention of moisture in the soil as affected by certain alkalis, gypsum, native phosphates, nitrates, and other fertilizers, and the waste products of glass and soda works.

PROPOSED WORK IN HORTICULTURE, B. C. BUFFUM, B. S. (pp. 9–15).—Work in landscape gardening and with vegetables and fruits has been begun. The comparative vitality of Northern-grown (Minnesota) and Colorado seeds will be tested in field experiments. Varieties of grasses and forage plants, native and imported, will be tested under irrigation. A number of species of native grasses growing at the station or elsewhere in Wyoming are mentioned. It is hoped that a

thorough botanical survey of the State may be made. The irrigation equipment of the station is briefly described.

GEOLOGY OF THE LARAMIE PLAINS, J. D. CONLEY, PH. D. (pp. 15–18).—A brief account of the geology of this region, from which the following is taken:

In giving the geological horizon of the Wyoming University experiment farm, grass fields, and garden the writer is at variance with the United States geological maps, which place the Laramie Plains in the Dakota Group.

From a study of excavations made in the city of Laramie and of the red sandstone quarries to the north it is certain that Laramie and the grass fields are in the Triassic formation. The red sandstone strata dips about 30 degrees to the west, passing beneath the Big Laramie River at the experiment garden, and must be several thousand feet beneath the surface at the experiment farm, 2 miles to the west. * * * Some Middle or Upper Cretaceous fossils are found 25 miles north of Laramie, and also in the Laramie Group, 20 miles to the northwest. At the latter point a stratum of coal dips northwest toward the foothills. The crest and southeast side of the mountain, of which the Laramie Group was once the northwestern slope, seems to have been carried away. This mountain must have extended to within a few miles of the experiment farm, at which point another mountain probably rose to the east, the west slope of which was covered by the Laramie Group, conformable with the Cretaceous and Triassic beneath. The latter mountain has also been torn down by the hand of time, laying bare the Cretaceous formation, whose crumbling and disintegrated rocks, mixed with local drift gravel, form the soil of the experiment farm.

NOTE ON SOIL ANALYSIS, J. D. CONLEY, PH. D. (p. 18).—Analyses of soils from each of the station farms will be published in a future bulletin. The following brief general statement is made regarding the soil of the station farm at Laramie:

"There is enough alumina in the soil at the Wyoming University experiment farm to give it body and a good consistency. It is a light, sandy loam, possessing enough of the essential ingredients for the native grasses to thrive well under irrigation alone. On a neighboring ranch in similar soil, the blue joint (*Agropyrum glaucum*) has produced 1½ tons per acre."

FLORA OF THE WYOMING UNIVERSITY EXPERIMENT FARM, A. NELSON, M. S. (pp. 18–21).—This is a brief preliminary report on a few species of the plants found growing wild on the station farm. The following species are described: *Townsendia sericea*, *Phlox caespitosa*, *P. douglasii*, *Echinocactus simpsoni*, *Œnothera caespitosa*, mountain lily (*Leucocrinum montanum*), plantain (*Plantago eripoda ?*), *Opuntia rafinesquii*, Rocky Mountain bee plant (*Cleome integrifolia*), *Malvastrum coccineum*, yarrow (*Achillea millefolium*), golden-rod (*Bigelovia graveolens*, var. *albicaulis*), thistle (*Cnicus scariosus*), wormwood (*Artemisia pedatifida ?*), larkspur (*Delphinium azureum*).

WEATHER REPORT FOR APRIL AND MAY, 1891, A. M. SAWIN, M. S. (21–23).—A tabulated record of temperature and precipitation for April and the first 15 days in May, 1891, prepared by Dr. L. S. Barnes, of Laramie.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 85 (NEW SERIES), JUNE, 1891 (pp. 241–302).—This includes articles on the acreage of cotton, wheat, oats, barley, and rye; the condition of these and other crops, including fruit; official statistics of foreign crops; the agriculture of Chili; European crop report for June; and the freight rates of transportation companies.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. III, NOS. 9 AND 10, JUNE, 1891 (pp. 359–432).—The principal articles in this double number are a Report of a Discussion on the Gypsy Moth (*Ocneria dispar*) at a conference held at Boston, Massachusetts, March 4, 1891; abstract of a paper on the Ravages of *Liparis* (*Psilura*) *monacha* in Germany and Means of Defense, by B. E. Fernow, read before the Entomological Society of Washington, March 5, 1891; A New Scale Insect (*Lecanium pruinosum*, n. sp.) from California, by D. W. Coquillett; Notes on the Habits and Earlier Stages of *Cryptophasa unipunctata*, Don., in Australia, by H. Edwards; Steps Toward a Revision of Chambers's Index, with Notes and Descriptions of New Species (continued), by Lord Walsingham; Description of Certain Lepidopterous Larvæ (*Pholisora hayhurstii*, *Triptogon imperator*, *Orgyia definita*, and *Apatela tritona*), by H. G. Dyar.

BULLETIN NO. 23.

OBSERVATIONS AND EXPERIMENTS IN THE PRACTICAL WORK OF THE DIVISION (pp. 83).—This includes the reports of the six permanent field agents of the Division for 1890, a brief summary of which was published in the Report of the Secretary of Agriculture for 1890, pp. 261–264.

Nebraska insects, L. Bruner (pp. 9–18).—Brief notes on the prevalence in Nebraska in 1890 of the corn root worm (*Diabrotica longicornis*), cutworms, corn ear worm (*Heliothis armigera*), codling moth (*Carpocapsa pomonella*), green-striped maple worm (*Anisota rubicunda*), and locusts or grasshoppers; and a list, with brief notes, of sixty-four species of insects which have attacked sugar beets in Nebraska. Spraying with arsenites or kerosene emulsion is an effective means of repressing most of these insects.

Various methods for destroying scale insects, D. W. Coquillett (pp. 19–36).—Accounts of experiments with hydrocyanic acid gas for the red scale (*Aonidia aurantii*, Maskell); with washes of resin, caustic soda and fish oil, and of lime and sulphur, singly or together, or combined with salt, for the San José scale (*Aspidiotus perniciosus*, Comstock); and with corrosive sublimate, glue, or aloes for different species of scales. The simplified tents used in the hydrocyanic acid gas treatment are described. It has been found that orange trees are less liable to injury by the gas when treated at night. The resin wash was found to be a very effective as well as inexpensive remedy for the San José scale. Glue gave good results, but is comparatively costly.

Experiments with resin compounds on Phylloxera, and general notes on California insects, A. Koebele (pp. 37–44).—Experiments with various resin washes for the *Phylloxera* in Sonoma Valley, California, are reported. The most satisfactory formula is caustic soda (77 per cent) 5 pounds, resin 40 pounds, and water to make 50 gallons:

First the soda should be dissolved over fire with 4 gallons of water, then the resin added and dissolved properly, after which the required water can be given slowly while boiling to make the 50 gallons of compound. This will make 500 gallons of the diluent, sufficient for 100 plants, and costing about 84 cents.

Observations are also reported on several species of the genus *Clisiocampa*, a noctuid larva (*Tæniocampa*) which injures fruit trees, *Caloptenus devastator*, and *Camnula pellucida*.

Entomological notes for the season of 1890, *M. E. Murtfeldt* (pp. 45–56).—Notes are given on the prevalence in Missouri of chinch bugs, cankerworms, cutworms, *Gortyna nitela*, *Heliothis armigera*, *Phyllotreta vittata*, *P. sinuata*, *Chætocnema pulicaria*, *Conotrachelus nenuphar*, plant lice, *Parasa chloris*, *Euclea querceti*, *Empretia stimulea*, *Phobetron pithecium*, *Limacodes scapha*, *Lagoa crispata*, *Saturina io*, *Datana angusii*, *D. ministra*, *Orgyia leucostigma*, *Ichthyura inclusa*, and *Hyphantria cunea*. A carabid beetle (*Plochionus timidus*) was observed to prey extensively on the fall webworm (*Hyphantria cunea*). Four new enemies of the apple are described, *Penthina chionosema*, *Proteopteryx spoliana*, *Steganoptycha pyricolana*, and *Gelechia intermediella* (?).

Under the head of experiments with insecticides are given accounts of experiments with X. O. dust, buhach, arsenites of ammonia, and petroleum sludge. It was found that dry X. O. dust blown from a bellows during the middle of the day is a thoroughly satisfactory remedy for plant lice of all kinds. The arsenites of ammonia, when used according to the manufacturer's directions, one tablespoonful to a gallon of water, proved to be an efficient insecticide, but badly scorched the leaves of peach and cherry and slightly damaged the foliage of plum, apple, rose, and squash. The petroleum sludge arrived too late for satisfactory trial, but Miss Murtfeldt thinks that its intolerable and persistent odor is a serious obstacle to its general use, especially in small gardens.

Work of the season, H. Osborn (pp. 57–62).—Notes on the following insects observed in Iowa in 1890: *Crambus exsiccatus*, leaf hoppers (*Jassidæ*), grasshoppers and crickets in grass, *Pempelia hammondii*, *Papilio turnus*, *Selandria cerasi*, *Datana ministra*, *Diabrotica longicornis*, *D. vittata*, *D. 12-punctata*, *Lophyrus abbotii*, and *Trichobaris trinotatus*. The last two are new to the State. Successful tests of arsenite of ammonia as an insecticide are also reported.

Some of the insects affecting cereal crops, F. M. Webster (pp. 63–79).—This relates largely to experiments and observations during more than 6 years, with reference to the number and development of broods of the Hessian fly, chiefly in Indiana. It was found that throughout Indiana this insect is double-brooded. The article also contains observations on the effect of the larvæ on the plants, especially on the color, and on the effect of the weather in the development of the full brood, together with a résumé of preventive and remedial measures.

BULLETIN NO. 25.

DESTRUCTIVE LOCUSTS, C. V. RILEY (pp. 62, plates 12, figs. 11).—A popular account of the geographical distribution, destructive appearances, life history, and habits of the following species of injurious locusts found in the United States: Rocky Mountain locust (*Caloptenus spretus*), lesser migratory locust (*C. atlantis*), non migrating red-legged locust (*C. femur-rubrum*), California devastating locust (*C. devastator*), differential locust (*C. differentialis*), two-striped locust (*C. bivittatus*), pellucid locust (*Camnula pellucida*), and American acridium (*Schistocerca americana*). The remedies and devices for the destruction of locusts are described and discussed. The bulletin is illustrated with a map of the United States, showing the distribution of the Rocky Mountain locust, and various kinds of apparatus used in the repression of locusts are shown.

CIRCULAR NO. 2 (SECOND SERIES), JUNE, 1891.

THE HOP PLANT LOUSE (pp. 7, plate 1, figs. 5).—A popular account of the life history of *Phorodon humuli*, with suggestions regarding remedies, and descriptions of spraying apparatus, prepared in view of the appearance of this insect in alarming numbers in New York, Oregon, and Washington. Reference is made to the record of investigations of this insect in the Annual Report of this Department for 1888. The remedies recommended are, (1) spraying with kerosene emulsion or fish-oil soap in the spring, or preferably in the fall after hop picking; (2) the destruction of all wild plum trees in the hop-growing regions; (3) the burning or drenching of the hop vines with kerosene emulsion soon after the crop is harvested.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The function of the root tubercles of leguminous plants.—A review by H. W. Conn.—The function of the root tubercles has been as much discussed as their nature and structure.* At first they were regarded as purely parasitic and therefore injurious rather than beneficial to the plant. It was soon found, however, that they contained an unusually large amount of nitrogenous matter,† and they were for a time supposed to be reservoirs of compounds of nitrogen.‡ It was next discovered that the plants possessing root tubercles contained more nitrogen than those without them, and it was thought that in some way they enabled the plants to obtain an extra amount of nitrogen from the deeper layers of the soil.§ To-day it is pretty definitely proved that they have some connection with the power possessed by legumes of acquiring atmospheric nitrogen.

It is only within recent years that plants have been known to acquire nitrogen in large quantities from the air. The classical experiments of Boussingault, Lawes, Gilbert, and Pugh were for a time thought to prove that plants do not possess this power. In 1881, Atwater instituted a series of experiments, which were repeated in 1882, and brought positive evidence of the acquisition of large quantities of nitrogen from the air by peas during their period of growth. He concluded that it was extremely probable, though not absolutely certain, that the free nitrogen of the air was thus assimilated. Later experiments revealed large losses of nitrogen during germination and early growth. In the accounts of these investigations it was urged that this loss of nitrogen was probably caused by microbes; that it helped to explain why previous experimenters had failed to find proof of the acquisition of atmospheric nitrogen by plants, especially legumes, but that the negative results obtained by the latter were also due to the exclusion of the action of electricity or microbes, by which the assimilation of

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* For a résumé of recent research on the nature of root tubercles, see Experiment Station Record, vol. II, p. 686.

† de Vries, Landw., Jahrb. 6, (1877).

‡ Schindler, Jour. f. Landw., 33 (1885); Brunchorst, Ber. d. bot. Ges., 3 (1885).

§ Ward, Phil. Trans. Roy. Soc., 1887.

atmospheric nitrogen might be aided.* Other experimenters, including Hellriegel and Wilfarth, Wolff, Bréal, and Lawes and Gilbert, have since verified the conclusions thus reported in 1881–84. To day it is generally accepted that legumes at least acquire large amounts of atmospheric nitrogen. The leaves perhaps may be unable to absorb this element from the air, but the indications have been growing that the roots of the plant do in some way obtain large quantities of nitrogen from the atmosphere.

The relation of the root tubercles to the acquisition of atmospheric nitrogen was first suggested by Hellriegel, who was aided in his work by Wilfarth. Their results were published in two papers.† Hellriegel found that the Gramineæ and the Leguminoseæ differ radically from each other in their relation to nitrogen. The former can not flourish in a soil devoid of nitrogenous compounds. For a short time they grow readily enough, but as soon as the material supplied in the seed is used up the plants begin to turn yellow, become stunted, and never show any increase in nitrogen over that contained in the seed. They are, in fact, nitrogen-starved, for if nitrogen is added to the soil at the time that the starvation period begins, a recovery takes place. The Gramineæ are unable to make use of atmospheric nitrogen. With the leguminous plants, different results were obtained. In experiments with peas, Hellriegel verified previous observations by finding that these plants do undoubtedly gain nitrogen from the atmosphere. He observed that when they were grown in soils consisting of pure quartz sand thoroughly freed from nitrogen compounds, and fed with materials containing no nitrogen, the plants flourished and eventually showed a considerable increase in nitrogen. In the growth of these plants in nitrogen-free soil he found two marked stages. The development is rapid at first, and continues until the reserve material in the seed is exhausted. Then there occurs a somewhat sudden cessation of growth, similar in character to the starvation period observed in Gramineæ.

In the case of the legumes, however, the plant soon recovers; its leaves turn green again, the growth goes on in a normal manner, and final analysis shows that nitrogen has been accumulated. Considerable variation was noticed in the growth of plants under these conditions, even though all were treated seemingly alike. Of two plants growing side by side, one was sometimes vigorous and the other dwarfed and stunted. The vigorous plants all had tubercles on their roots, while the others either had none or relatively few. The recovery of the plants

* The results of the experiments of the first series were briefly reported at the meeting of the American Association for the Advancement of Science in 1881; those of the first and second series together were reported at the meetings of the British and American Association for the Advancement of Science in 1884, and in detail in the American Chemical Journal, vol. VI, p. 365, and those of the later series in the same journal, vol. VIII, pp. 327 and 398.

† Tagebl. d. 59 Versamml. deut. Natur. fu. Aerzte, Wiesbaden, 1887, and Zeitsch. d. Ver. f. Rübenz. Ind. d. d. R., 1886 and 1888.

from the first period of nitrogen starvation was observed to be closely connected with the growth of the tubercles, and the inference was drawn that the cause of the renewed vigor of the plants was to be found in the root tubercles. Thinking that microörganisms in the soil might in some way be connected with this process, Hellriegel cultivated peas in soils which contained no nitrogen, but which were watered with a soil infusion. This infusion was made by shaking in water soil from a fertile field, and then allowing it to settle. The water thus treated, he argued, would contain whatever organisms there might have been in the soil, and if the production of the tubercles and the fixing of nitrogen by plants in nitrogen-free soil was due to the action of these organisms, plants watered by such an infusion ought to indicate it. The results were very striking. All of the peas watered with soil infusion showed a vigorous growth, an increase in nitrogen, and numerous root tubercles. Those not thus inoculated showed wide variations from vigorous growth to complete failure to recover from the starvation period. To make the result more positive, peas were cultivated in nitrogen-free soils which had been sterilized by heat. In this case no recovery from the starvation period occurred unless the plants were first treated with the soil infusion. Finally it was proved that the soil infusion was powerless to produce any effect if it was first sterilized by heat.

From these results of Hellriegel's investigations the conclusion was warranted that leguminous plants in some way acquire the power of assimilating nitrogen from the atmosphere, but that this power does not inhere in the plants themselves. In order that they may make use of the nitrogen in the air, it is necessary that certain organisms in the soil should penetrate into their roots. These organisms growing in the roots of the legumes produce the root tubercles, and in some way enable the plants to assimilate atmospheric nitrogen. Under ordinary conditions these microörganisms are freely supplied to the plant from the soil, but in the culture experiments cited above in order to make sure that they would be present, the plants were inoculated with an aqueous infusion prepared from a rich soil.

Two other points of significance were brought out by Hellriegel: (1) If plants were grown in soils containing nitrogen, they could assimilate this equally well whether root tubercles were present or not, thus indicating that the tubercles are not necessary to the assimilation of soil nitrogen. (2) Different species of legumes seemed to have different species of tubercle microörganisms associated with them, for it was found that while soil in which peas had been growing might be well adapted to produce the necessary tubercles in other pea plants, it might not produce them in other species of legumes.

These surprising results of Hellriegel's inquiries led to other experiments on the functions of the root tubercles and the power of plants to assimilate atmospheric nitrogen. Hellriegel's general results have been confirmed by several observers, among whom may be mentioned Frank, Prazmowski, Atwater and Woods, Lawes and Gilbert, Beyerinck and

Laurent. But although, as will be seen below, there is a consensus of all experimenters as to the general relation of the tubercles to the assimilation of nitrogen, the differences regarding details lead to almost diametrically opposite views as to the interpretation of the phenomena. The most important of the recent publications on this subject are those of Frank and Prazmowski. These observers have been working for several years and have each published several papers. In 1890 each published a long account of the results of his previous work, and with it a summary of his views on the whole question. These two papers were published so nearly at the same time that neither contains any reference to the other. A review of these two papers will give us the best outline of the present condition of the discussion.

The extensive investigations of Frank* were carried on with several species of legumes which he cultivated in pots containing soils of various kinds. In one series a nitrogen-free soil and in a second series a rich humus was used. Sterilization of the soils was accomplished by heating, and he admits that the heat produced various chemical changes, especially in the humus, which interfered with the success of his experiments. His results indicated that legumes do gain nitrogen from the air and that the power in some cases at least is connected with the formation of root tubercles. According to his experiments, however, different species of legumes differ in this respect. Beans, for example, show no greater amounts of nitrogen when tubercles are present than when they are absent. For such plants the tubercle is to be regarded simply as a parasite. In the case of the lupine and the pea, the tubercles are of more value. Of course none of these plants grow vigorously in nitrogen-free soil under ordinary conditions, but when they are provided with the tubercle organism their growth is more vigorous, they develop more leaves, and they assimilate more carbon and more atmospheric nitrogen. But according to Frank even these plants gain no advantage from the tubercles if they are growing in rich soil. When growing in soil containing nitrogen they have no need of the microbes, being able to assimilate plenty of nitrogen without them. Plants grown in the rich humus used in some of his experiments showed an equal growth and fixation of nitrogen whether they developed tubercles or not. In some experiments plants without tubercles actually developed better than those with tubercles, a fact which he thought might be explained by the injurious action of the sterilization on the chemical condition of the soil. Frank concluded then that under ordinary conditions the tubercles are of no use to the plant. But when the plants are growing in poor soil, and especially in one lacking in nitrogen, they have not of themselves sufficient vigor to develop and assimilate nitrogen from the air. The microbes of the tubercles under these conditions serve as a stimulant to the plant. Under their influence the plant takes on new vigor, grows normally, and assimilates nitrogen from the only possibly source—the air.

*Landw. Jahrb., 1890, pp. 523-640.

Frank does not think, however, that the tubercle organism is itself the agent of the assimilation of nitrogen. This power belongs to the plant and the presence of the microbe simply stimulates the plant to greater growth in poor soils, and hence indirectly increases its power of assimilating nitrogen. In his experiments he found that the whole activity of the plant was stimulated by the presence of the microbe, its growth including its development of chlorophyl, and its assimilation of carbon as well as of nitrogen. He urges that other plants besides legumes have the power of nitrogen assimilation, though perhaps in less degree. Even some algæ, he thinks, can do this. He claims further that his experiments show that the legumes can assimilate atmospheric nitrogen even when they are free from tubercles. This they can not do readily in poor soil, since their general vigor is here too small, but in rich soils they do assimilate great quantities of nitrogen and he thinks that they get it from the air. Moreover the cultivation of the tubercle organism in artificial culture does not indicate that it can nourish itself on atmospheric nitrogen. For these reasons he concludes that there is no ground for attributing the nitrogen assimilation solely to the microbe, but that it is really a property of the plant, stimulated to excess in certain cases by the presence of the microbe. While then the tubercle organism is of value for certain species of legumes growing in poor soil, it is of no value in rich soils, and for certain species it is of no value at all. He found no reason for believing that different species of tubercle organisms were associated with different species of legumes, and concluded that in ordinary soils in which legumes had been growing the microbe was present in sufficient quantities to produce an abundance of tubercles.

Prazmowski* has reached somewhat different conclusions. His experiments were fewer in number, but were performed with greater precautions against accidental errors. The plants were all grown in specially prepared vessels, so arranged that the contents could not come in contact with any air that had not first been filtered through cotton to deprive it of germs. The stem of the plant protruded through a specially guarded opening in the top of the vessel, and the leaves were thus exposed to the air. In the globe-shaped culture vessel he placed sand which had been most thoroughly purified of all traces of nitrogenous matter by washing, and freed of all microbes by sterilizing at a high heat. All water used in the culture was conducted to the bottom of the vessel by a sterilized glass tube, so arranged as to prevent the possibility of contamination by bacteria from the air. Into this vessel of purified sand he introduced solutions containing the plant foods with which he wished to experiment, and thoroughly sterilized the whole apparatus by heat. He then introduced a germinating seedling, using all antiseptic precautions. During the experiment he caused a stream of filtered air to pass through this soil, and all water used was thoroughly

* Landw. Vers. Stat., 38 (1890), pp. 5–62; Experiment Station Record, vol. II, p. 686.

sterilized. In this way he reduced the possibility of the influence of the contaminating microbes to the lowest terms. After the experiment he made an examination of his soils to see if he had succeeded in preventing the access of contaminating organisms. In most of his experiments this had not been accomplished, but some of the soils did appear sterile, even after the plants had been growing for weeks, and the results of these experiments did not differ from the others. A special advantage of this method of experimenting was in his knowing exactly what his plants had to feed upon, thus avoiding all errors produced by rain or dust or from unknown constituents in his soils. The great value of his experiments, therefore, lay in his so controlling all of the conditions that he could directly determine the action of the tubercle organism.

Prazmowski's experiments comprised four series: (1) Plants grown in sterilized soil, fed with nitrogen-free food, and watered with sterilized water; (2) plants grown in sterilized soil, fed with nitrogen-free food, and watered with a water which contained some of the tubercle microbes obtained from pure cultures of these organisms; (3) plants grown in soils supplied with calcium nitrate, in addition to other salts, and watered with sterilized water; (4) plants grown in soils with the nitrogen ration and watered with water containing the tubercle microbe. The results in all his experiments were uniform. In all cases where the microbe was added in the water, tubercles developed, the plants were vigorous, and showed by final analysis an increase of nitrogen. In the nitrogen-free soils watered with sterile water, there were no tubercles and no increase in nitrogen over that contained in the seed, while the inoculated plants in the same soils all showed an increase of nitrogen, sometimes as much as sixfold. In plants fed with a nitrogen ration there was in all cases an increase in nitrogen, but the inoculated plants always showed a greater increase than those not inoculated.

Prazmowski also carried through a series of experiments with water cultures, but with less success. In water cultures containing no nitrogen he found exactly the same results as in his soil cultures. But the plants which he grew in water cultures containing a nitrogen ration and inoculated with the tubercle organism, did not do so well. Some injurious disease affected them (there were only two experiments) and prevented their normal growth. Their leaves turned yellow and they did not develop tubercles in the normal manner, although inoculated with the tubercle organism several times. As was to be expected, when analyzed these plants showed less nitrogen than the inoculated plants which developed normally on the nitrogen ration.

Prazmowski does not think it has yet been positively determined whether the nitrogen fixed by these plants is derived from the free nitrogen of the air or from some form of combined nitrogen, though he regards it as much more probable that it is the free nitrogen. Hellriegel's experiments have shown that the legumes can gain nitrogen

when supplied with air deprived of ammonia and nitric acid. He repeated the experiments of Boussingault in confined air with the exception that he inoculated his plants. This difference changed the result from negative to positive, and showed that with the aid of the microbes, legumes did obtain nitrogen from the air when ammonia and nitric acid were absent.

Admitting this conclusion, Prazmowski sees three possible methods by which the organisms produce their effect on the plant: (1) The bacteria may produce certain substances (ferments?) by the aid of which the plant is able to fix free nitrogen in a compound which the plant incorporates into its own substance; (2) the bacteria themselves may seize upon the nitrogen and incorporate it in compounds in their own bodies and then the plant may make use of the bacteria for food; (3) the assimilation of nitrogen may be a function of the combined life of the plant and the microbe acting together, the necessary energy being the result of their symbiosis. Of these three possibilities Prazmowski inclines to the second, thinking that the bacteria, after fixing the atmospheric nitrogen in their own bodies, under the influence of the plant tissue degenerate into bacteroids and are finally absorbed by the plant.

It will be seen that there are several points of difference between the views of Frank and Prazmowski. The most important is the claim made by Frank that the tubercles are of value to the plants only when growing in poor soil, while those plants which grow in rich soil gain an equal amount of nitrogen whether or not they are supplied with tubercles. Other more recent experiments do not confirm this conclusion. Atwater and Woods* have found that the tubercles do have a very important relation to the fixation of atmospheric nitrogen, even when nitrogen is supplied to the roots in the form of nitrates. Wilfarth † in a recent address criticises Frank's experiments as inexact and containing numerous sources of error. He thinks that the experiments by which Frank undertook to prove that other plants beside legumes can fix nitrogen, are unsatisfactory, the amount of nitrogen acquired by the plants being within the limits of error. Wilfarth also mentions further experiments of his own which directly contradict the claim of Frank, that the tubercles are of no value in rich soils, and promises soon a more complete description of these investigations.

Bréal ‡ made a study of the root tubercles—their composition, their formation through the agency of bacteria, the methods of inoculation, and the gain of nitrogen by legumes, peas, beans, and alfalfa in water, artificial soil and otherwise. He observed that inoculation could be readily brought about in the roots of legumes growing in water or in soil by piercing a root and inserting a portion of another root or other material containing bacteria; that cultures of the bacteria could be

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* Am. Chem. Jour., vols. XII and XIII.
† Landw. Vers. Stat., 38, p. 322.
‡ Ann. Agron., 15 (1889), p. 529.

used for the inoculation; and that the plants thus inoculated and bearing root tubercles gained large quantities of nitrogen from the air.

Atwater and Woods* made some two hundred trials with oats, corn (maize), and peas in purified sand. In all cases mineral salts and in some cases nitrogen in the form of nitrates, were supplied in the nutritive solutions. In some cases aqueous infusions of the soil in which peas had grown were added to the solutions, in others not. Root tubercles appeared upon the peas, but not on the oats or corn. There was little apparent relation between the soil infusions and the number of root tubercles on the peas. Some of the plants had large numbers of tubercles, others did not, and this was true not only of the plants in different pots, but of the different plants in the same pot, and it was likewise the case whether the soil infusion had been applied or not. As the sand had been carefully washed and ignited at a high temperature, it was believed that bacteria or their spores were supplied from the air. Neither oats nor maize showed any gain of atmospheric nitrogen. With the peas, whenever the root tubercles were abundant the gain was large. Where there were no root tubercles there was generally a loss of nitrogen, and the amount of gain varied with the abundance of the root tubercles, both with and without nitrates in the nutritive solutions.

Lawes and Gilbert† describe several series of experiments undertaken for the purpose of verifying Hellriegel's results. They experimented with peas, red clover, vetches, blue lupines, yellow lupines, and alfalfa. Their plants were cultivated under three different conditions, (1) in washed sand and fed with no nitrogen; (2) in the same, but inoculated with a soil infusion; (3) in rich garden soil. Their results differed somewhat with the different species of legumes, but in general confirmed those of Hellriegel. The inoculated plants always developed tubercules and fixed nitrogen, while those uninoculated failed to do so with any regularity. They did not sterilize their soils and therefore found tubercles present in nearly all of their plants. Their results gave no indication as to whether the tubercles are of any value for the fixation of nitrogen by plants growing in rich soils. The conclusions of Lawes and Gilbert are especially interesting since their earlier work led them to deny the power of plants to fix atmospheric nitrogen.

More recently Laurent‡ has again confirmed the conclusions as to the relation of tubercles to the power of nitrogen fixation. His work is chiefly confined to the study of the methods of growing the microbes, and his paper gives no results of analysis. He succeeded, however, in growing the plants successfully in water cultures and getting a luxuriant development of tubercles and a vigorous growth of the plants. A thorough aëration of the water was necessary for this purpose, and the lack of aëration is offered as the explanation of the failure of other

*Connecticut Storrs Station Bulletin No. 5 and Annual Report for 1889, and Am. Chem. Jour., *loc. cit.*

† Proc. Roy. Soc., 47 (1890), No. 1.

‡ Ann. de l'Inst. Pasteur, 1891, pp. 105–140.

investigators. Laurent further finds that the tubercle organism can be cultivated successfully in solutions containing no nitrogen, thus confirming results which had previously been obtained by Prazmowski and Bréal, and adding a significant fact to our knowledge of the relation of these microbes to atmospheric nitrogen. Although the tubercle organisms certainly grow in nitrogen-free solutions, Laurent has as yet been unable to show by analysis that they actually fix nitrogen from the air, on account of the small amount of nitrogen present in such cultures.

Summary.—From this brief review it will be seen that our present knowledge of the functions of the root tubercles is somewhat as follows:

(1) The tubercles are produced by organisms which ordinarily live in the soil, especially in soils in which legumes have previously been grown. It is not yet definitely determined whether different species of microbes are associated with different species of legumes.

(2) The tubercles are undoubtedly in some way connected with the power of the plant to acquire nitrogen from the atmosphere. Their presence enables the legumes to accumulate nitrogen when growing in a nitrogen-free soil, and probably increases the nitrogen assimilation in all soils.

(3) The nitrogen assimilated comes from the atmosphere. In all probability the free nitrogen of the air is thus assimilated.

(4) It has not yet been determined whether the microbe itself derives the nitrogen from the air and is then used by the plant for food, or whether the power of assimilating nitrogen belongs to the plant and is only stimulated by the microbe, or whether this power is a function of the combined life of the two organisms growing together.

New experiments concerning the assimilation of nitrogen by plants, B. Frank and R. Otto (*Deut. landw. Presse,* 18 (1891), *p.* 403).—Determinations of the nitrogen in the leaves of red clover, lucern, wood pea, cole rape, hemp, grape, caraway, and yellow lupine, collected from growing plants in the morning and in the evening and immediately dried at 60° C., showed the leaves collected in the evening to be richer in nitrogen in every case than those collected in the morning. The difference was most prominent in the cases of lucern, red clover, and wood pea. The percentages of nitrogen found in the leaves of these plants, calculated for dry matter, are given as follows:

	Evening.	Following morning
	Per cent.	*Per cent*
Red clover	2 087	1.486
Lucern	4 382	2.906
Wood pea	4.124	3.088

In other experiments the influence of sunlight on the nitrogen content of leaves after cutting, was observed. Leaves of red clover and yellow lupine were gathered in the morning, and while a part of them were dried immediately at 60° C., the remainder were placed with their stems

in distilled water and exposed to the sunlight during the day. On analysis it was found that the leaves exposed to the sunlight during the day contained more nitrogen than those dried as soon as gathered. Since the cut leaves had no connection with the plant, the increased nitrogen must have been derived through other means than the roots.

A difference was also noticed in the percentage of asparagin in the water-free leaves of red clover gathered in the morning and in the evening:

Evening, June 9	per cent asparagin	0.973
Morning, June 10	" " "	0.277

The authors believe these results merit the conclusion that green fodders, as red clover for instance, should be cut in the evening soon after sundown to secure the greatest food value, and that likewise the food value of pasturage is greatest at this time, especially if the day has been bright and warm.

Relation of climatic conditions to the formation of nicotine in tobacco, Adolf Mayer (*Landw. Vers. Stat.*, 38, *pp.* 453–467).—In experiments recently published the author pointed out the influence of fertilizing materials on the quality of tobacco, and showed with reference to nicotine that its formation in the plant was favored by a heavy application of easily available nitrogenous materials, and that a high percentage of nicotine was in no instance observed where the supply of plant food was deficient (see *Landw. Vers. Stat.*, 38, *p.* 92, or Experiment Station Record, vol. II, p. 457).

The author calls attention to the well-known fact that young plants and the younger parts of the plant in general contain a comparatively small amount of nicotine; also that plants which are not topped (seed plants) are comparatively poor in nicotine.

To further study the conditions of growth favorable to the development of this alkaloid, experiments were made in 1890 with reference to the influence of light, heat, soil water, and the humidity of the atmosphere. The author states at the outset that the effects of individuality on the formation of nicotine in tobacco are quite strong. To study the effects of temperature, plants treated otherwise the same, were grown in different cases out of doors, in a greenhouse with southern exposure, and from seed sown late in the season, so that the plant developed at a relatively low temperature. As the days were shorter the plants of the last series naturally received less light than the others. The first two series were harvested August 18 to 20; the last, November 11. The average amount of dry matter contained in the leaves per plant and the average percentage of nicotine are given for the different conditions as follows:

	Dry matter.	Nicotine.
	Grams.	*Per cent.*
Grown at low temperature (planted late)	22.5	2.1
Grown at medium temperature (in open air)	30.9	3.0
Grown at high temperature (in greenhouse)	32.5	4.1

The elaboration of nicotine, according to these figures, increased regularly with the increase in temperature.

The effect of light was observed by comparing the development of nicotine in plants grown in the sunlight with that of those shaded on all sides except the north side, thus receiving no direct light, or those grown in the sunlight but having a number of leaves covered with tin foil. Plants grown under these different conditions contained the following percentages of nicotine:

	Per cent.
Grown in full direct sunlight	2.9 4.9
Grown in shade	1.5 2.2
Leaves fully exposed to light	No. 1..4.4 No. 2*..0.6
Leaves of same plants shaded	No. 1..2.2 No. 2..0.35

Although the variations in nicotine content were quite large in plants receiving like treatment, the differences in this respect between plants receiving unlike treatment were greater, and indicate that direct sunlight had a favorable influence on the formation of nicotine, and further, that this effect is to a considerable extent local, since the leaves exposed to the sunlight produced twice as much nicotine as those on the same plants which were shaded. The author has shown on previous occasions that tobacco rich in nicotine is in general dark colored. He suggests that since the production of nicotine is favored by light, it may be possible to produce relatively light or dark leaves by cultivating the plants close together or farther apart.

To study the effects of water in the soil, an attempt was made to supply respectively 80, 60, and 40 per cent of the amount of water by weight which the soil was capable of absorbing, and though rains prevented this plan from being accurately carried out, these conditions of soil moisture were approximated. The plants grown under the different conditions contained the following percentages of nicotine:

Percentages of nicotine.

	Water in large excess.		Water in excess.		Kept as dry as practicable.			
	Plant 1.	Plant 2	Plant 3.	Plant 4.	Plant 5.	Plant 6.	Plant 7.	Plant 8.
Nicotine	*Per cent.* 1.20	*Per cent.* 1.05	*Per cent* 1.75	*Per cent* 1.45	*Per cent.* 3.10	*Per cent* 2.90	*Per cent.* 3.10	*Per cent.* 2.70

The plants receiving the largest quantity of water produced the least dry matter, and those which were protected from the rain and kept quite dry, the most dry matter. The production of organic matter and of nicotine was thus hindered by the presence of large quantities of water in the soil. These results, in the opinion of the author, corroborate

* Harvested one month earlier.

statements previously made, that in general any factor which hinders the vigorous development of the plant is likewise disadvantageous to the formation of nicotine.

Variation in the transpiration of the plants was brought about by covering a number of plants with glass cases closed on all sides, that is, increasing the humidity of the atmosphere, while others were grown in the open air and allowed to transpire naturally. The results follow:

		Per cent nicotine.
Unhindered transpiration	Plant 1	3.10
	Plant 2	2.90
Transpiration artificially diminished	Plant 3	3.20
	Plant 4	3.55

Since in hindering the transpiration the temperature was raised and heat has been shown to be favorable to a high nicotine content, it seems quite doubtful if any good effects are to be attributed to the diminishing of the transpiration.

The results of the investigation seem to point to the fact that heat, light, and a comparatively dry rather than an excessively moist soil are favorable to the formation of nicotine, and that the effect of these factors on the nicotine content is more marked than on the total organic matter of the plant.

Increase of the fat content of milk by feeding cocoanut cake, R. Heinrich (*Landw. Ann. d. meck. pat. Vereins*, 1891, *pp.* 65–72).—Two experiments to compare the effect of cocoanut cake and peanut cake on the fat content of milk, were made under the direction of the author in 1889 and 1890 at the experiment station at Rostock, Germany. The first experiment was made with two Breitenburg cows which had calved in February, 1889, and lasted from June 1 to December 19, 1889. During this time 1 kilo of peanut cake or 1.5 kilos of cocoanut cake per day were fed with a basal ration composed of rye meal, hay, oat straw, and beet leaves or beets, and which remained as nearly as possible the same throughout the experiment. The cows were alternated from one ration to the other in periods of 3 weeks during the whole experiment, one cow receiving the cocoanut ration while the other received the peanut ration. The cocoanut ration was at all times slightly lower in protein but somewhat richer in fat and carbohydrates than the peanut ration. The milk was analyzed weekly. The average amount of butter fat produced per day by each cow on each of the rations was, from June 1 to December 7, as follows:

Butter fat produced per day.

	Cow No. 1.	Cow No. 2.
	Kilo.	*Kilo.*
On the peanut cake ration	0 365	0.413
On the cocoanut-cake ration	0.306	0.456

The daily production of butter fat thus increased in the case of cow No. 2 when the cocoanut cake was fed. The author suggests that the absence of a similar increase with cow No. 1 may have been due to a dislike which it showed for the cocoanut cake. He further suggests that the favorable action of the cocoanut-cake ration may possibly have been caused by the slightly increased amount of protein which that ration contained.

A second experiment was made in 1890, in which the daily rations consisted of 2 kilos of peanut cake and 12.5 kilos of oat straw, or 5 kilos of cocoanut cake and 10 kilos of oat straw. Both rations contained the same amounts of dry matter, protein, and carbohydrates; but the cocoanut-cake ration contained 350 grams more fat than the other. These two rations were alternated as in the previous trial, the periods in 1890 being 4 weeks long instead of three, and the milk analyzed twice each week. The two cows fed in the previous experiment and a third cow which ate the cocoanut cake readily were used in 1890. The first two had calved in April and May, 1890, and the third had given milk for over 2 years. The experiment lasted from June 11 to August 29 with Nos. 1 and 2, and to December 19 with No. 3. The results are summarized as follows:

Percentages and total amounts of fat in milk.

	Percentage of fat.			Total amount of fat per day.			
	Morning.	Noon.	Night.	Morning.	Noon.	Night.	Total.
	Per cent.	*Per cent.*	*Per cent.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
No. 1. With cocoanut cake..	3.49	5.39	4.39	239	174	179	592
With peanut cake.....	3.06	4.12	3.45	184	124	122	430
Increase on cocoanut cake	0.43	1.27	0.94	55	50	57	162
No. 2. With cocoanut cake..	3.28	4.25	3.63	178	121	116	415
With peanut cake....	2.47	3.28	2.71	158	102	90	350
Increase on cocoanut cake..........	0.81	0.97	0.92	20	19	26	65
No. 3. With cocoanut cake ..	3.41	5.02	4.21	119	94	81	294
With peanut cake.....	2.81	3.71	3.48	102	73	73	248
Increase on cocoanut cake	0.60	1.31	0.73	17	21	8	46

The results show that in these cases the fat of the milk was considerably increased, both in percentage and total amount, when the cocoanut-cake ration was fed, but they indicate a considerable difference in the animals regarding this point. No data are given as to the other constituents of the milk.

It is to be remembered that the cocoanut-cake ration contained 350 grams more fat than the other. The author states that the increased yield of butter fat might be accounted for by this increased amount of fat in the food, and he refers to recent experiments by Klein in Königsberg, which indicate that a part of the fat of the food may pass directly into the milk.

EXPERIMENT STATION NOTES.

ARKANSAS STATION.—R. L. Bennett, B. S., has been appointed director. The governing board at present includes J. T. Henderson, H. G. Bunn and B. C. Black.

COLORADO STATION.—F. J. Annis, M. S., is acting director and secretary; F. Huntley, B. S., assistant agriculturist; and F. C. Avery, treasurer.

CONNECTICUT STORRS STATION.—H. M. Smith has been appointed assistant chemist to the station vice H. B. Gibson, B. A., whose present address is Robert Schumann, Strasse 4 pt., Leipsic, Saxony.

INDIANA PURDUE UNIVERSITY.—The special bulletin on commercial fertilizers, issued May, 1891, by H. A. Huston, M. A., as State chemist, contains statements regarding the sources of the nitrogen, phosphoric acid, and potash in fertilizers, statistics regarding the commercial fertilizers sold in Indiana in 1890, directions for field experiments with fertilizers by farmers, and tabulated analyses of 143 samples of fertilizers.

"Twenty-nine thousand tons of commercial fertilizers were sold in the State during 1890. This contained 413 tons of actual potash valued at $49,600; 837 tons of ammonia valued at $301,120; 4,628 tons of phosphoric acid, of which 2,537 tons were 'available' and valued at $405,920 and 2,091 insoluble and valued at $125,460; making a total value of $882,100. Included in this are 9,550 tons of bone, raw and steamed, the actual selling price of which must have been not less than $300,000. The money actually expended for commercial fertilizers in Indiana during 1890 was less than 3 per cent of the value of the nitrogen, phosphoric acid, and potash that were exported from the State in corn and wheat alone during the same year."

MINNESOTA STATION.—Plans for a dairy building to cost $15,000 have been accepted, and it is expected that the building will be completed by November. T. L. Haecker has been elected instructor in butter making.

OKLAHOMA COLLEGE AND STATION.—The Agricultural and Mechanical College and Experiment Station for Oklahoma Territory have been located at Stillwater, Payne County. Two hundred and forty acres of land have been donated for the college and station, and the town of Stillwater has bonded itself for $10,000 for buildings. The board of directors organized June 23, 1891, includes Gov. George W. Steel, *ex officio*; Robert J. Barker, president; Amos Ewing, secretary; J. P. Lane, John Wimberly, and Arthur N. Daniels.

OREGON STATION.—G. W. Shaw has been elected chemist vice P. H. Irish, Ph. D.; E. R. Lake, M. S., is no longer a member of the station staff. The station bulletins will hereafter be printed at the station. Pig-feeding experiments are in progress, and experiments with wheat will be a prominent feature of the work of the station.

PENNSYLVANIA COLLEGE AND STATION.—J. B. Doyle, of Philadelphia, and Frank Knoche, of Harrisburg, have been elected members of the board of trustees vice J. A. Beaver and Cyrus Fox. J. W. Fields has been elected assistant chemist of the station vice H. B. McDonnell, M. D.

UTAH STATION.—Dynamometer tests of mowing machines and other farm machinery have recently been made at the station.

WASHINGTON STATION.—The station farm comprises 218 acres, 150 of which are under cultivation. It is estimated that the yield this year will be at least 50 bushels

per acre. A brick building is in process of erection, and it is expected that the station will be equipped for its work during the coming winter. George Lilley is director of the station.

WYOMING COLLEGE.—The name of the president of the college is A. A. Johnson, instead of T. A. Johnson, as printed in Circular No. 20 of this Office.

QUEENSLAND.—Bulletin No. 8 of the Department of Agriculture at Brisbane, issued February, 1891, is edited by E. M. Shelton, and is made up of abstracts of bulletins of the New Hampshire, Michigan, Tennessee, Missouri, Massachusetts Hatch, Alabama College, and Louisiana Stations.

RUSSIA.—A law enacted May 11, 1891, regarding the manufacture and sale of oleomargarine and artificial butter in the Empire is summarized in the *Milch Zeitung*, No. 49, 1891, as follows:

(1) The law understands by the term "margarine" the material prepared from fresh beef fat, after the separation of the stearine, according to the method of Mège Mouriés; and by "artificial butter," the material prepared from 100 parts by weight of margarine and 100 parts by weight of milk or 10 parts of cream.

(2) The manufacture of margarine and artificial butter is restricted to establishments fitted up exclusively for this purpose.

(3) Such establishments, as well as slaughterhouses furnishing them with crude materials, will be under the supervision of special officials, to be appointed by the minister of finance. The expense of this supervision is to be contributed by the manufacturers.

(4) It is forbidden (*a*) to color margarine or artificial butter the color of cows' butter; (*b*) to mix margarine or other fats with cows' butter for the purpose of selling, to bring such mixtures into the market or to store in places where cows' butter is kept or sold.

(5) All vessels in which it is exposed for sale must be plainly marked "Margarine" or "Artificial Butter." Tubs or boxes containing these materials must also bear the name of the manufacturer.

(6) All stores or establishments dealing in oleomargarine or artificial butter must display in a prominent place a placard to this effect.

(7) The selling of these materials in stores which are especially for the sale of dairy products is not allowable.

(8) The importation of these materials from other countries is forbidden.

(9) The Minister of Finance and the Minister of the Interior are charged with the execution of the law, and the seeing to it that the manufacture is carried on under proper sanitary conditions.

The penalty for offering adulterated cows' butter for sale, or the storing of such adulterated butter where cows' butter is made or sold, is forfeiture of the material and imprisonment not exceeding one month, or a fine not exceeding 100 rubles ($77). The penalty for disregard of the other clauses of the law as to manufacture and sale, is forfeiture of the material and a fine not exceeding 100 rubles.

STATION AT DARMSTADT, GERMANY.—According to a recent report by Prof. Paul Wagner*, 411 samples of Thomas slag were sent to the station for analysis during 1890. The percentages of phosphoric acid contained in these samples are grouped as follows: In 9 samples 10 to 12 per cent., in 72 samples 12 to 14, in 121 samples 14 to 16, in 110 samples 16 to 18, in 73 samples 18 to 20, in 26 samples over 20. The average percentage was 16.21 per cent. There was also considerable variation in the mechanical condition of the samples, the percentage of fine meal† ranging from 50 to 95; 89 samples contained less and 322 samples more than 75 per cent of fine meal.

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* Zeitsch. f. d. landw. Ver. Hessens.

† Experiment Station Record, vol. II, p. 523.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING JULY, 1891.

DIVISION OF STATISTICS:

Report No. 86 (new series), July, 1891.—Report of the Area of Corn, Potatoes, and Tobacco, and the Condition of Growing Crops; Freight Rates of Transportation Companies.

Fiber Investigation, Report No. 3.—A Report on Sisal Hemp Culture.

DIVISION OF FORESTRY:

Bulletin No. 5.—What is Forestry?

DIVISION OF BOTANY:

Contributions from the U. S. National Herbarium, vol. I, No. 4, June 30, 1891.—List of Plants Collected by Dr. Edward Palmer in 1890 in Western Mexico and Arizona.

OFFICE OF IRRIGATION INQUIRY:

Report of Special Agent in Charge of the Artesian and Underflow Investigations and of the Irrigation Inquiry for 1890.

Progress Report on Irrigation in the United States, part I.

Progress Report on Irrigation in the United States, part II.—Artesian and Underflow Investigations between the Ninety-Seventh Degree of West Longitude and the Foothills of the Rocky Mountains.

DIVISION OF GARDENS AND GROUNDS:

Papers on Horticultural and Kindred Subjects.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Bulletin No. 2, part II.—Digest of Annual Reports of the Agricultural Experiment Stations in the United Stations for 1888.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING JULY, 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:
  Bulletin No. 93, June 25, 1891.—Investigation of California Oranges and Lemons.
THE DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 13, July, 1891.—Leaf Blight of the Pear and the Quince.
AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:
  Bulletin No. 16, May, 1891.—Experiments in Pig Feeding; Composite Milk Samples Tested for Butter Fat.
IOWA AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 13, May, 1891.—Experiment in Feeding for Milk; Treatment of Fungous Diseases; Some Insects Destructive to Grass; Blossoms of the Orchard Fruits—their Relative Hardiness; Some Observations on Contaminated Water Supply for Live Stock.
LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:
  Bulletin No. 10 (second series).—Systematic Feeding of Work Stock a Preventive of Disease; Some of the Diseases of Farm Animals.
HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:
  Meteorological Bulletin No. 30, June, 1891.
MISSISSIPPI AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 15, June, 1891.—Feeding; Milk Testing Apparatus.
NEW JERSEY STATE AND COLLEGE AGRICULTURAL EXPERIMENT STATIONS:
  Bulletin No. 81, July 1, 1891.—Incomplete Fertilizers and Home Mixtures.
  Bulletin No. 82, July 3, 1891.—The Rose Chafer or Rose Bug.
NEW YORK AGRICULTURAL EXPERIMENT STATION:
  Ninth Annual Report, 1890.
CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 28, June, 1891.—Experiments in the Forcing of Tomatoes.
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:
  Annual Report of the Meteorological Division, 1890.
WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 14, February, 1891.—Farm and Garden Insects; Notes of the Season.
  Bulletin No. 16, April, 1891.—Forest and Shade-Tree Insects—Yellow Locust.
  Bulletin No. 17, May, 1891.—Forest and Shade-Tree Insects—Black Spruce.
AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF WISCONSIN:
  Bulletin No. 28, July, 1891.—The Construction of Silos.

DOMINION OF CANADA.

BUREAU OF INDUSTRIES, TORONTO, ONTARIO.
  Annual Report, parts I, II, III, IV, and V, 1889.
DEPARTMENT OF AGRICULTURE:
  Bulletin No. 12, June, 1891.—Indian Corn or Maize as a Fodder Plant; Report on the Chemical Composition of Certain Varieties of Indian Corn.
  Bulletin No. 13, June 2, 1891.—Report of Progress of the Work of the Experimental Farms.

EXPERIMENT STATION RECORD.

Vol. III. ISSUED SEPTEMBER, 1891. No. 2.

EDITORIAL NOTES.

Renewed interest in the investigations conducted at Rothamsted, England, under the direction of Sir John Bennet Lawes, has been awakened by the lectures of Mr. Robert Warington delivered before the Association of American Agricultural Colleges and Experiment Stations at its recent meeting in Washington, D. C. This course of lectures is the first of a series to be given once in two years in this country, in accordance with the provisions of what is known as the Lawes Agricultural Trust. The lectures of Mr. Warington will be published by the Department of Agriculture as a bulletin of this Office, and a summary of them will be given in the Experiment Station Record. The following general statements explanatory of the work carried on at Rothamsted have been taken for the most part from a pamphlet descriptive of the origin, plan, and results of the field and other experiments at that place, issued in June, 1891. As early as 1834 Mr. (now Sir) John Bennet Lawes began experiments in agriculture at his hereditary estate at Rothamsted, Hertfordshire, 25 miles from London. At first the experiments were with different fertilizers applied to plants in pots. Afterwards similar investigations were made in the field. Such striking results were obtained, especially in those experiments where the neutral phosphate of lime in bones, bone ash, and apatite, dissolved in sulphuric acid, were applied to root crops, that the scale on which the trials were made was enlarged from time to time. In 1843 the field experiments were so systematized that it is fairly claimed that "the foundation of the Rothamsted Experimental Station may be said to date from that time." For a number of years laboratory work was carried on in a barn, but the results obtained at Rothamsted attracted so much attention that a new laboratory was built by public subscription of agriculturists, and presented to Sir John in 1855. In the autumn of 1888 another building was erected, comprising two large rooms for the storing of specimens and for some processes of preparation, and also a drying room. The station now has a "collection of more than 40,000

bottles of samples of experimentally grown vegetable produce, of animal products, of ashes, or of soils, besides some thousands of samples not in bottles." Dr. J. H. Gilbert has been associated with Sir John since June, 1843, and has had charge of the laboratory. The number of assistants and other helpers has been increased from time to time. During the past twenty-five years the working staff has consisted of from one to three chemists and two or three general assistants employed in routine chemical work and in carrying out the details of field and feeding experiments. A botanical assistant has also occasionally been employed. Besides these workers, there have been from two to four computers and record keepers, a laboratory man, and other helpers. Chemical work has also been done for the station in London and elsewhere. In this way Mr. R. Richter, formerly connected with the Rothamsted laboratory, has made numerous ash analyses of animal and vegetable products at Charlottenburg (Berlin), Germany, where he is at present located.

"The general scope and plan of the field experiments has been to grow some of the most important crops of rotation, each separately, year after year for many years in succession, on the same land, without manure, with farmyard manure, and with a great variety of chemical manures, the same kind of manure being, as a rule, applied year after year on the same plat. Experiments on an actual course of rotation, without manure, and with different manures, have also been made."

Experiments with different fertilizers on wheat have been made for 48 years on 11 acres of land, on barley for 40 years on 4¼ acres, on oats 10 years on three quarters of an acre, on beans for from 27 to 32 years on 2¼ acres, on clover 29 years on 3 acres, on turnips 28 years on 8 acres, on sugar beets 5 years on 8 acres, on mangel-wurzels 16 years on 18 acres, on potatoes 6 years on 2 acres, on permanent grass 36 years on 7 acres, and on crops in rotation 44 years on 3 acres. Varieties of wheat have been tested during 15 years on from 4 to 8 acres. Wheat has been grown in alternation with fallow for 40 years on 1 acre, and in alternation with beans for 28 years on 1 acre. Experiments with various leguminous plants have also been made during 14 years on 3 acres. Comparative experiments with different manures have been conducted on other kinds of soils in other localities.

"Samples of all the experimental crops are taken and brought to the laboratory. Weighed portions of each are partially dried at 100° C., the dry matter determined, and then burnt to ash on platinum sheets in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference or analysis.

"In a large proportion of the samples the nitrogen is determined, and in some the amount existing as albuminoids, amides, and nitric acid.

In selected cases, illustrating the influence of season, manures, exhaustion, etc., complete ash analyses have been made, numbering in all more than 700. Also in selected cases, illustrating the influence of season and manuring, quantities of the experimentally grown wheat grain have been sent to the mill, and the proportion and composition of the different mill products determined. In the sugar beet, mangel-wurzel, and potatoes the sugar in the juice has in many cases been determined by polariscope, and frequently by copper also.

"In the case of the experiments on the mixed herbage of permanent grass land, besides the samples taken for the determination of the chemical composition (dry matter, ash, nitrogen, woody fiber, fatty matter, and composition of ash), carefully averaged samples have frequently been taken for the determination of the botanical composition, In this way, on four occasions, at intervals of five years, viz, in 1862, 1867. 1872, and 1877, a sample of the produce of each plat was taken and submitted to careful botanical separation, and the percentage by weight of each species in the mixed herbage determined. Partial separations, in the case of samples from selected plats (frequently of both first and second crops), have also been made in many other years."

More than 1,600 samples have been taken from the soils of the experiment plats at depths of from 9 to more than 100 inches. These have been submitted to a partial mechanical separation, and in a large number of cases the loss on drying at different temperatures and on ignition has been determined.

"In most the nitrogen determinable by burning with soda lime has been estimated. In many the carbon, and in many the nitrogen as nitric acid, and the chlorine have been determined. Some experiments have also been made on the comparative absorptive capacity (for water and ammonia) of different soils and subsoils. The systematic investigation of the amount and the condition of the nitrogen, and of some of the more important mineral constituents of the soils of the different plats, and from different depths, is in progress or contemplated."

Almost from the commencement of the experimental work at Rothamsted the rainfall has been measured by means of gauges.

"From time to time the nitrogen, as ammonia and as nitric acid, has been determined in the rain waters. The chlorine and the sulphuric acid have also been determined in a considerable series of samples."

The quantity and composition of the water percolating through soil at depths of 20, 40, and 60 inches, has been determined with the aid of three "drain gauges" constructed for the purpose. The drainage waters from the differently manured plats of the permanent experimental wheat fields are frequently analyzed.

"Professor Frankland has determined the nitrogen, as ammonia, as nitric acid, and as organic nitrogen, and also some other constituents, in many samples both of the rain and of the various drainage waters

collected at Rothamsted. The late Dr. Voelcker also determined the combined nitrogen, and likewise the incombustible constituents, in 65 samples of the drainage waters; and Dr. W. J. Russell has determined the sulphuric acid in some of the monthly mixed samples of rain water.

"The nitrogen existing as nitric acid, sometimes that in other forms, and also some other constituents, are and for some time past have been determined periodically in the Rothamsted laboratory, in both the rain and the various drainage waters."

For several years experiments were made to determine the amount of water given off by graminaceous, leguminous, and other plants during their growth. Similar experiments have also been made with various evergreen and deciduous trees.

"Having regard to the difference in the character and amount of the constituents assimilated by plants of different botanical relationships under equal external conditions, or by the same description of plants under varying conditions, observations have been made on the character and range of the roots of different plants, and on their relative development of stem, leaf, etc. In the case of various crops, but more especially with wheat and beans, samples have been taken at different stages of growth and the composition determined in more or less detail, sometimes of the entire plant and sometimes of the separated parts. In a few cases the amounts of dry matter, ash, nitrogen, etc., in the above-ground growth of a given area, at different stages of development, have been determined. The amounts of stubble of different crops have also occasionally been estimated."

Among the most widely known of the experiments at Rothamsted are those with reference to the assimilation of free nitrogen by plants, commenced in 1857 and conducted for several years. The conclusion arrived at, that our agricultural plants do not themselves directly assimilate the free nitrogen of the air by their leaves, has been generally accepted. Since the experiments of Atwater have shown that the free nitrogen of the air is assimilated by leguminous plants, and those of Hellriegel and others have shown that this assimilation takes place through the aid of microörganisms, either within the soil or in symbiosis with plänts of a higher order, in which process the root tubercles of these plants play an important part, experiments at Rothamsted have confirmed the results obtained elsewhere.

" Experiments with the animals of the farm were commenced early in 1847, and have been continued at intervals up to the present time.

"The following points have been investigated:

"(1) The amount of food and of its several constituents consumed in relation to a given live weight of animal within a given time.

"(2) The amount of food and of its several constituents consumed to produce a given amount of increase in live weight.

"(3) The proportion and relative development of the different organs or parts of different animals.

"(4) The proximate and ultimate composition of the animals in different conditions as to age and fatness, and the probable composition of their increase in live weight during the fattening process.

"(5) The composition of the solid and liquid excreta (the manure) in relation to that of the food consumed.

"(6) The loss or expenditure of constituents by respiration and the cutaneous exhalations, that is, in the mere sustenance of the living meat-and-manure-making machine. [This has not been determined with the respiration apparatus, but only by calculations based on the amounts of dry matter, ash, and nitrogen in the food, feces, and urine.]

"(7) The yield of milk in relation to the food consumed to produce it, and the influence of different descriptions of food on the quantity and on the composition of the milk. * * *

"Independently of the points of inquiry above enumerated, the results have supplied data for the consideration of the following questions:

"(1) The characteristic demands of the animal body (for nitrogeneous or nonnitrogeneous constituents of food) in the exercise of muscular power.

"(2) The sources in the food of the fat produced in the animal body.

"(3) The comparative characters of animal and vegetable food in human dietaries."

In these investigations several hundred animals, including cattle, sheep, and pigs, have been used.

An extensive investigation regarding to the use of the sewage of towns as fertilizers for different crops, especially for grass, was carried on in coöperation with the late Professor Way. The amount, composition, and nutritive value of crops grown with this fertilizer were studied.

"The chemistry of the malting process, the loss of food constituents during its progress, and the comparative feeding value of barley and malt have been investigated."

Experiments commenced in 1884 are still in progress with reference to the changes which crops undergo in the process of ensiling, and the relative value of different kinds of silage as feeding stuffs.

The records and results of the investigations by the Rothamsted Station have been published in the *Journal of the Royal Agricultural Society of England*, *Journal of the Chemical Society*, *Philosophical Transactions of the Royal Society*, *Journal of the Society of Arts*, *Reports of the British Association for the Advancement of Science*, and elsewhere. The list of articles published 1847–91, inclusive, embraces 115 titles. Sir John Lawes has recently presented complete sets of these publications to a considerable number of the agricultural colleges and experiment stations in this country.

The Rothamsted Station has been maintained entirely from the private resources of its founder, who, for the perpetuation of the work, has placed in the hands of trustees a fund of £100,000, the laboratory, and certain tracts of land. In accordance with the provisions of the deed of trust the station is now carried on under a committee of management, of which Sir John is a member.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

California Station, Bulletin No. 93, June 25, 1891 (pp. 6).

ANALYSES OF CALIFORNIA ORANGES AND LEMONS, G. E. COLBY, PH. B., AND H. L. DYER.—In a brief introduction to the bulletin, Director Hilgard states that owing to an increase in the working force of the station, investigations of California fruits with regard to their comparative nutritive value and fertilizing ingredients will be carried on more extensively than formerly. This article comprises brief descriptive notes and tabulated proximate and ash analyses for 23 samples of oranges and 4 of lemons. The varieties of oranges included in the samples analyzed were Navel, Mediterranean Sweet, St. Michaels, Malta Blood, Valencia, Tangerine, and a seedling; the lemons were Eureka and Arroyo Grande Pride. The average results of the analyses were as follows:

Averages of proximate analyses of oranges and lemons.

	Physical analysis.					Juice.					
	Average weight.	Rind.	Pulp, less juice.	Seeds	Juice average.	Solid contents by spindle.	Total sugars by copper (inversion).	Cane sugar (polariscope).	Acid (citric).	Nitrogen in fresh fruit.	Albuminoids in fresh fruit equivalent to nitrogen.
	Grams.	*P. ct.*	*P. ct.*	*P. ct.*	*c. c.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Oranges:											
Navel	300	28.4	27.7	......	107	12.80	9.92	4.80	1.02	0.211	1.31
Mediterranean Sweet.	202	27	24	0.8	86	2.60	9.70	4.35	1.38	0.154	0.96
St. Michaels	138	19.2	25.9	1.6	65.4	12.10	8.71	3.48	1.35	0.228	1.43
Malta Blood.	177	31	24	......	71	13.55	10.30	5.85	1.61	0.168	1.05
Lemons:											
Eureka	104	32	24.5	0.12	38	11.90	2.08	0.57	7.66	0.151	0.94

Averages of ash analyses of oranges and lemons.

	Oranges.	Lemons.
	Per cent.	*Per cent.*
Pure ash in fresh fruit	0.432	0.526
Composition of pure ash:		
Potash (K_2O)	48.94	48.26
Soda (Na_2O)	2.50	1.76
Lime (CaO)	22.71	29.87
Magnesia (MgO)	5.34	4.40
Oxide of iron (Fe_2O_3), and alumina (Al_2O_3)	0.97	0.43
Oxide manganese ($Mn\ O_4$)	0.37	0.28
Phosphoric acid (P_2O_5)	12.37	11.09
Sulphuric acid (SO_3)	5.25	2.84
Silica (SiO_2)	0.65	0.66
Chlorine (Cl)	0.92	0.39
Total	99.98	98.98

The results of the analyses are discussed as follows:

Oranges, proportion of rind to flesh.—Considering the matter first from the standpoint of the consumer, it seems that although the Navel is the largest of oranges, it has, contrary to the popular impression, no advantage with respect to the proportion of skin to flesh over either the Mediterranean Sweet or St. Michaels. The average Navel can fairly be considered as containing nearly 72 per cent of flesh, while the average Mediterranean Sweet shows 73 per cent, and the St. Michaels 81 per cent.

Juiciness or proportion of juice to flesh.—A comparison of the figures in the table shows that of the named varieties examined the Navel is the driest, while the St. Michaels has the largest proportion of juice, the Mediterranean Sweet being next and the Malta Blood third.

These facts will be better understood by reference to the little table below, which gives the percentage ratios.

Variety.	Proportion of rind to flesh.		Proportion of pulp to juice in flesh.	
	Rind.	Flesh.	Pulp.	Juice.
Navel	28.4	71.6	39	61
Mediterranean Sweet	27	73	33	67
St. Michaels	19	81	31	69
Malta Blood	31	69	36	64

Evidently the hard and solid, although thin rind of the Navel weighs heavier in the balance than the more "corky" one of the Mediterranean Sweet, and doubtless outweighs also that of many seedlings. * * *

Sugar content of the juice.—The table shows the maximum of sugar [11.2 per cent] in the hill-grown Navel from Pomona (No. 6), but this is approached very closely [11.1 per cent] by Navel No. 8, the Mediterranean Sweet No. 9 [, 10.09 per cent], the Malta Bloods from Pomona Nos. 18 [11.1 per cent] and 19 [11.02 per cent], and the Tangerine from San Gabriel No. 22 [11.03 per cent]. It is notable that the latter shows at the same time the highest proportion of cane sugar [7.41 per cent] to be found in the whole series, the Pomona Navels and Malta Bloods standing next. To what extent the proportion of cane sugar determines the sweetness to the taste, is a matter not yet fully understood, the proportion between the other two sugars (grape and fruit), not yet determined, being an essential factor in the case.

The average sugar content of the fully ripe Navels (gathered in April and May) from all localities is 10.8 per cent. Against this we find Mediterranean Sweets from Riverside and Pomona, Nos. 11 and 12 (gathered in May), to average 9.7 per cent only; while the seedling from Smartsville, gathered in January, shows a little over

10 per cent, thus indicating a very early maturity. The Valencia orange from Pomona (No. 21) shows a decidedly lower sugar percentage [9.2 per cent], as does the contemporaneous Malta Blood from Riverside [8.8 per cent]. The St. Michaels shows the lowest average of all the oranges (8.71 per cent), although the roundish sample from Pomona falls only a little below 10 per cent.

Comparing these data with those of previous years, heretofore published, we find that the sugar percentage of the Navel appears to have risen from 9.89 per cent to 10.80 per cent. For the Mediterranean Sweet the figure remains practically identical. For the St. Michaels it is higher than we have found it this season.

Acid in the juice.—In respect to acid, we note at once the maximum in the Malta Blood of over 2 per cent, with an average of 1.6 per cent in the three samples examined. The next highest figures occur in the early samples of Mediterranean Sweet from Smartsville, a maximum of 1.68 per cent; but the average of the May samples from Riverside and Pomona is 1.23 per cent. The St. Michaels of Marysville, January 22, shows the next highest maximum with 1.46 per cent, but in the later samples of April and May we find in the Riverside sample (No. 14) a minimum of 0.84 per cent, with an average of 1.07 for the four later samples examined. In contrast to the Malta Blood, therefore the St. Michaels counts among the varieties of low acid, combined, however, with rather a low sugar percentage, as stated above.

The Valencia rates in nearly the same respect with the St. Michaels, while the Tangerine shows the low figure of 0.87 per cent of acid, with, at the same time, a very high sugar percentage. A former analysis showed for its close relative, the Mandarin, a lower minimum of acid (0.36 per cent), and the highest sugar percentage on record—13.84 per cent.

The Navel justifies the statement, made in a former report, of the low acid percentage even in samples gathered as early as January and still more in those of later date from Riverside and Pomona. The minimum of all (0.77 per cent) is shown by the Pomona fruit (No. 6), with, at the same time, the highest sugar percentage (11.20) of the series. In the aggregate the average acid percentage of the Navel is the lowest of all, with the highest average of sugar (9.92 per cent), outside of the Malta Blood. These data, together with its firm flesh, thin and smooth rind, and excellent keeping qualities, sufficiently explain the great preference given it in our markets.

Comparing the results obtained in 1891 with those in previous publications of this Department (1879–87) we note first an apparent increase in the average weight of the several varieties. We also find that while the percentages of rind show very nearly the same average as in 1891, there is a marked discrepancy in respect to juiciness, the pressed pulp averaging about 25 per cent less in earlier specimens. How far these differences may be due to influences of season or accident in sampling is difficult to decide with the data before us; the more so as the acid and sugar percentages show very nearly the same absolute as well as relative figures. Increased age of the bearing trees may possibly account for some of these differences. * * *

Nutritive values—nitrogen content.—The flesh-forming ingredients (albuminoids) of any article of food being of great importance as regards its proper uses, it is of special interest to compare in this respect the orange with other fruits, and the different varieties of oranges with each other. According to the latest European data, oranges stand first in the amount of albuminoids (1.73 per cent), prunes second (0.78 per cent), peaches (and probably apricots) third, bananas and grapes fourth, while apples and pears stand nearly the lowest on the list (0.375 per cent). Our determinations of the same substances in California oranges as a whole (rind included) show materially smaller figures, averaging 1.20 per cent; and as it is known that the rind is very poor in these substances, we are forced to conclude that the California fruit is less nourishing than that of Sicilian production. Much lower percentages, however, are quoted for oranges from other sources. Here again the differences observed may be largely due to the age of the trees bearing the fruit, which in California is usually the minimum.

Of the entire series, the Riverside Navels show the highest content of albuminoids (1.54 per cent), while the average of the Pomona sample is 1.18 per cent only. Next highest to the Riverside Navels come the St. Michaels from Marysville, Riverside, and Pomona, with an average of 1.4 per cent; nearly the same is shown by the Riverside Malta Bloods. The average of the Mediterranean Sweets falls below 1 per cent, that from Pomona falling to 0.91 per cent. The Malta Blood and Niles seedling show the minima of 0.69 per cent and 0.75 per cent. The Valencia and Tangerine, with the Eureka lemon, seem to range about 1 per cent.

Ash composition and nitrogen content.—As will be seen by reference to Bulletin No. 88 of the station [see Experiment Station Record, vol. II, p. 272], the orange stands second (grapes being first) among orchard fruits in the quantity of mineral matter withdrawn from the soil. Heretofore we have been obliged to base all conclusions bearing upon the ash and nitrogen of these fruits on European data; we are now enabled to present for oranges and lemons the outcome of California growth. The following summary (based on averages from the large table) shows in tabular form the amounts, in pounds, of the soil ingredients extracted by an orange or lemon crop that will have to be replaced by fertilization.

	Total ash.	Potash.	Phosphoric acid.	Nitrogen.
Oranges:				
European (seedless)—	*Pounds*	*Pounds.*	*Pounds.*	*Pounds.*
Crop of 1,000 pounds	6.07	2.78	0.67	2.69
Crop of 20,000 pounds	121.40	55.60	13.40	53.80
California—				
Crop of 1,000 pounds	4.32	2.11	0.53	1.83
Crop of 20,000 pounds	80.40	40.14	10.60	36.60
Lemons:				
Crop of 1,000 pounds	5.57	2.69	0.61	1.51
Crop of 20,000 pounds	111.40	53.80	12.20	30.20

It thus appears that so far as oranges are concerned the California fruit draws materially less upon all the soil ingredients that have to be replaced by fertilization than the European; while as regards the lemon, it approaches closely to the European standard for the orange, save in the much smaller draft upon nitrogen. * * *

Lemons.—The incompleteness of the data concerning lemons renders it inadvisable to enter upon any extended discussion, the more so as no extended data from the Old World are available for comparison. It will be noted that the most important ingredient of this fruit, viz, the acid percentage, considerably exceeds, for the Eureka lemon [7.66 per cent] at least, the commonly assumed average, and in the case of No. 26, from San Gabriel [7.88 per cent], the acid percentage is extraordinary. This point alone should insure to California-grown lemons a high position in commerce.

The relatively large percentage of sugar shown by the analyses is a feature which will further commend them to the consumer's taste as against the percentages usually reported. It will be observed, however, that very great differences exist in the proportion of rind to flesh and extractable juice. In this respect the lemons of Pomona [2.22 per cent] and Ontario [2.37 per cent] stand at the head of the list as far as it goes.

In ash composition there is no material difference between the oranges and lemons examined. With a more extended series the variations in both would doubtless be shown to run parallel.

Colorado Station, Third Annual Report, 1890 (pp. 227).

Report of Director, C. L. Ingersoll, M. S. (pp. 3–9).—Brief statements regarding the work of the station in 1890.

Plan of experiments for 1890 (pp. 10–13).—An outline of the work planned for the sections of agriculture, chemistry, meteorology

and irrigation engineering, and botany and horticulture. Previous reports of work in similar lines may be found in the Annual Reports of the station for 1888 and 1889 (see Experiment Station Bulletin No. 2, part I, p. 27, and Experiment Station Record, vol. II, p. 392).

REPORT OF AGRICULTURAL SECTION, R. H. MCDOWELL, B. S. (pp. 14–24).—Tabulated data and brief notes are given for 12 varieties of oats, 12 of barley, 21 of wheat, 17 of sorghum, 3 of millet, and 32 of foreign wheat. There are also notes on tests for soil variations with corn and wheat and on experiments with millo maize, vetches, lupines, Russian sunflowers, lentils, Aztec coffee, cowpeas, flax, grasses, clovers, and other forage plants.

REPORT OF CHEMICAL SECTION, D. O'BRINE, D. SC. (pp. 25–28).—The results of a large share of the work of this section were published in Bulletins Nos. 10, 11, and 12, of the station (see Experiment Station Record, vol. II, pp. 11, 99, 319). Two hundred and seventy-nine analyses were made during the year, including sugar beets, irrigation waters, grasses, loco weed, larkspur, etc. Forty-two samples of rain and snow were analyzed with reference to nitrates and ammonia.

REPORT OF SECTION OF BOTANY AND HORTICULTURE, C. S. CRANDALL, M. S. (pp. 29–54).—This includes tabulated data and brief notes for 26 varieties of strawberries, 6 of blackberries, 6 of raspberries, 87 of grapes, 40 of potatoes, 46 of tomatoes (28 of which have been previously reported), 43 of peas, 9 of peppers, 6 of cucumbers, 8 of cabbages, 3 of onions, and 6 of sugar beets. One hundred and seventy species of weeds have been observed in the locality of the station, of which 42 "are very abundant and very persistent in cultivated ground."

REPORT ON APIARY, C. M. BROSE (pp. 55, 56).—A brief account is given of an experiment in growing the Chapman honey plant (*Echinops sphærocephalus*). The station owns 31 colonies of bees.

REPORT OF SECTION OF METEOROLOGY AND IRRIGATION ENGINEERING, L. G. CARPENTER, M. S. (pp. 57–155).—This contains articles on water supply, irrigation statistics of 1890, irrigation literature, meteorological observations, and observations of soil temperatures.

Water supply.—The water supply of 1890, while in some respects better than in previous years, was still insufficient for the purpose of irrigation. A table is given showing the maximum flow of nine streams in the State in 1888 and 1890. The discharge of the Cache a la Poudre River is tabulated for each day from November 1, 1889, to November 8, 1890, inclusive. The total flow of this stream for the 12 months is calculated to have been 248,193 acre-feet.

This is enough to cover 248,193 acres 1 foot deep; or this amount would be enough to cover 386 square miles 1 foot deep. As the area of the watershed of the Poudre above the measuring weir is 1,008 square miles, this is equal to a run-off of a sheet of water 4½ inches deep over the whole area. * * * Taking the basin as a whole, the average precipitation above the point where the gauging station is placed may be fairly estimated at 14 inches. This being true, the total run-off equals one third of the precipitation.

Comparing the flow of the river during the irrigation season with the area cultivated, we get an approximation to the average duty of water as it has been in this valley during this year. It can not, however, be said to be a just estimate, as the water was confessedly not sufficient. A just measure of the duty of water should be based on the amount that is sufficient to furnish the crop the needed amount of moisture. Much of the land this year did not receive all that was needed, and the late crops were successful only because of the copious rains of August. We may take the season as from April to September, as the water between the first days of these months was nearly all used for irrigation, much of that of April being stored and used subsequently. In these 5 months the total flow was 211,811 acre-feet, or, as the area watered from the waters of the river is very nearly 135,000 acres, it was equivalent to a depth of 18.6 inches over the irrigated area. Hence, during these 5 months each cubic foot per second was called upon to furnish water for 196 acres. This is greater than the duty when there is sufficient water, for, as stated above, much land suffered from a scarcity.

In addition to the water from the river, there was a rainfall which amounted to 9.64 inches at the college—near the exit of the river from the foothills—and of about 8 inches at Greeley, at the lower end of the valley, or an average of over 8 inches from the rain. The total depth of water from both sources has then been nearly 27 inches.

The duty of water found for the whole district by the method above used, gives a result that seems excessive to all who are intimately acquainted with this valley. The method is defective inasmuch as it does not take into account the areas which did not have sufficient water. To get the duty of water which is practically useful, we should know the amount that would be used if the irrigator had all that he needed and at the times when he needed it, and a supply scant enough to insure that none goes to waste.

Tabulated data are given for the duty of water under the Cache a la Poudre Canal No. 2 (one of the oldest of the large canals on the river) from May 27 to September 10, inclusive.

For the last four days in May the amount flowing into the canal equals the flow of 1,791 cubic feet per second for one day; in June, 10,425; in July, 6,213; in August, 3,186, and for the portion of September here given, 662; or for the whole period, 22,277. As the flow of one cubic foot per second is sufficient to cover one acre 2 feet deep, very nearly, or 2 acre-feet in one day, the amount of water used by this canal from May 27 to September 10 was 44,500 acre-feet. As it is known with some degree of accuracy that the area which depends on water from this ditch is between 24,000 and 25,000 acres, this flow would therefore be sufficient to cover the whole area with water over 21 inches deep. If the flow during May and April be added, this depth would be increased. The rainfall also increases the depth of the water that has been used on the land. In the interval covered by these measures, the average duty, excluding rain, is nearly 120 acres per second-foot, while for the valley as a whole it is 196 acres. During the month of June, water was used at the rate of 72 acres per second-foot, assuming that all the land was irrigated. As a matter of fact, the irrigation of this month was confined almost entirely to the crops of cereals and alfalfa, which occupied about two thirds of the 25,000 acres.

The above facts suggest that if one wishes to use the duty of water to determine the amount of water he will need to water a given area, that the average duty is very misleading; and that during the period when water is wanted in greatest quantities, the duty ordinarily taken as the basis of water rights in Colorado, viz, 55 acres per second-foot, is the safer guide.

Irrigation statistics of 1890.—Tabulated estimates are given of the area under ditch in Colorado, the area irrigated, mileage of canals, and cost of irrigation works during 1889. Canal construction was most

active in the Arkansas Valley, where the area brought under ditch aggregates some 700,000 acres. It is estimated that the total area under ditch in Colorado at the end of 1890 was 6,337 square miles, or 4,068,409 acres; the area irrigated, 1,635,000 acres. The mileage of canals was 6,317, not including numerous short ditches in the mountain regions. The cost of irrigation works in Colorado is roughly estimated at $10,980,000.

Irrigation literature.—A list of 71 works bearing on the subject of irrigation, with brief comments on the character and scope of each.

Meteorological observations.—Tabulated data are given of the monthly precipitation at the station for 14 years (1872–90), and for twenty localities in the State for 1890; daily observations of the dew-point and relative humidity for each month of 1890; the monthly evaporation at the station and at the San Luis and Rocky Ford substations; monthly and daily observations of the sunshine in hours and minutes for 1890 at the three stations; daily actinometer readings from April 1 to November 12, 1890, inclusive; daily thermometer readings and range of temperature for each month of 1890; daily terrestrial radiation; thermometer readings for each month of 1890; and the means of two daily readings of the barometer for each month of 1890.

Annual summary of meteorological observations for 1890.

Stations.	Mean pressure.	Air temperature (degrees F.).					
		Highest.	Lowest.	Mean.	Mean daily range.	Greatest daily range.	No. of days minimum temperature below 32° F.
	Inches						
Fort Collins	25.010	95.3	–20	49.08	31.33	48.09	168
Del Norte	22.644	89	–16	44.80	32.12	....	217
Rocky Ford	....	104	–10	50.7	....	....	147

Stations.	Humidity.			Wind.		Precipitation.			Sunshine.	
	Mean dew-point.	Mean relative humidity.	No. of days on which dew was observed.	Prevailing direction.	Maximum velocity per hour.	Total precipitation (rain and melted snow).	Total snow fall.	No. of days on which 0.01 inch of rain or melted snow fell.	Per cent.	Total hours.
					Miles.	*Inches.*	*Inches.*			
Fort Collins	40.19	62.48	44	W and SW.	70	11.435	17.8	56	65.1	2,798
Del Norte	32.12	73.37	....	W.	....	8.77	24.75	47	....	....
Rocky Ford	42.73	71.9	....	W.	....	6.93	14.5	27	71.4	....

Soil temperatures.—A tabular record of the weekly means of soil temperatures at depths of from 3 to 72 inches for three sets of soil thermometers placed in soils varying in elevation and moisture.

REPORT OF GRASS STATION, C. S. CRANDALL, M. S. (pp. 156–183).—This is a first year's report of experiments, conducted under the direction of the Division of Botany of the U. S. Department of Agriculture,

in testing different species of grasses and forage plants grown without irrigation. Notes and tabulated data are given for a number of species of grasses and other forage plants sown on plats of different sizes. A list of 41 species of weeds which made their appearance on the grass plats is also given, and a list of grasses, the seeds of which were collected in Colorado from August 29 to September 12, 1890. Of the 99 named species sown at the station in the spring of 1890, 29 species of grasses and 8 of forage plants germinated.

During the weeks following germination, these exhibited all degrees of endurance. Some made scarcely any growth and died after a short struggle; others lived through till late in the summer. Four of the grasses and three of the forage plants have carried a portion of the plants produced through the whole season and are still alive at this writing, November 22. The grasses are *Lolium perenne, Holcus lanatus, Agropyrum tenerum*, and *Festuca elatior*.

The fact that these grasses, sown alone on fresh-broken prairie, have had sufficient power of endurance to retain life in even a portion of the plants produced through a hot and unusually dry summer, is certainly enough to warrant their further trial. Of course it remains to be seen whether the plants now alive will live through the winter. If they do, the strong roots they have will enable them to start early and grow to maturity. The forage plants now alive and giving promise of growth next season are the kidney vetch (*Anthyllis vulneraria*), burnet (*Poterium Sanguisorba*), and *Galega officinalis*.

REPORT OF SAN LUIS VALLEY SUBSTATION, H. H. GRIFFIN, B. S. (pp. 184–201).—Brief notes are given for experiments with wheat, barley, oats, rye, buckwheat, corn, field peas, millet, clover, alfalfa, English rye grass, and sainfoin. Notes, in some cases tabular, are also given for 23 varieties of peas, 12 of cabbages, 2 of cauliflowers, 4 of beets, 5 of sugar beets, 4 of carrots, 8 of onions, 6 of cucumbers, 8 of muskmelons, 7 of watermelons, 21 of beans, 9 of tomatoes, 4 of pumpkins, 12 of squashes, 81 of potatoes, 10 of sweet corn, 1 of sunflowers, 15 of apples, 4 of pears, 2 of plums, 2 of cherries, 16 of strawberries, 3 of blackberries, 6 of raspberries, 2 of gooseberries, 2 of currants, and 3 of grapes. Ten species of forest trees were planted in the spring of 1890. A summary of meteorological observations is also given.

REPORT OF ARKANSAS VALLEY SUBSTATION, F. L. WATROUS (pp. 202–218).—Brief notes are given on experiments with wheat, oats, peanuts, watermelons, muskmelons, beans, potatoes, sweet potatoes, corn, tomatoes, buckwheat, sugar beets, barley, rye, pumpkins, squashes, sweet corn, sorghum, millo maize, peas, cucumbers, cabbages, cauliflowers, eggplants, and celery. There are also brief notes on orchards of apples and pears, the vineyard, and the strawberry bed.

REPORT OF SPECIAL EXAMINING COMMITTEE, D. W. WORKING (pp. 219–222).—This is by a committee of the Colorado State Grange.

REPORT OF TREASURER, F. J. ANNIS, M. S. (pp. 223, 224).—This is for the fiscal year ending June 30, 1890.

Massachusetts Hatch Station, Meteorological Bulletin No. 30, June, 1891 (pp. 4).

This includes a daily and monthly summary of observations for June, 1891, made at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

New Hampshire Station, Bulletin No. 13, May, 1891 (pp. 11).

EFFECT OF FOOD ON THE HARDNESS OF BUTTER, A. H. WOOD, B. S., AND C. L. PARSONS, B. S. (pp. 3–9).—The following experiments were made to study the effect of gluten meal as compared with that of corn meal, cotton-seed meal, or skim milk, and the effect of silage as compared with that of hay on churnability and the character of the butter produced.

In the comparison of gluten meal with corn meal, four lots of two cows each were used. The rations were as follows, lots A and B being fed alternately on the first and second rations in periods of 2 weeks each, and lots C and D on the third and fourth rations:

Pounds per animal daily.

	Silage.	Hay.	Middlings.	Gluten meal	Corn meal.
First ration	44	6	3	6	....
Second ration	44	6	3	....	6
Third ration	41	6	3	1	5
Fourth ration	41	6	3	5	1

The milk given on the last 2 days in which each ration was fed was taken for testing. The cream was separated by a De Laval hand separator, and was churned after standing about 24 hours (apparently still sweet). Samples of the butter and buttermilk were analyzed, and the relative hardness of the butter was determined by the depth in millimetres, to which a pointed glass rod, weighing 10 grams and falling through a perpendicular glass tube 1 metre in height, penetrated the sample of butter. These determinations of hardness were all made at a temperature of 15.5° C., and it is recommended that the butter be allowed to stand in a cool room for several days previous to the test. The details of the method are described. "Except in very soft butters the differences in triplicate determinations are seldom over 1 millimetre."

The yield of milk on the different rations is not given. From tabulated data regarding the completeness of the separation of the butter fat in churning and the character of the butter, the following summary is taken:

Gluten meal vs. corn meal.

	Fat in buttermilk.		Hardness of butter.	
	Gluten-meal ration.	Corn-meal ration.	Gluten-meal ration.	Corn-meal ration.
	Per cent.	*Per cent.*	*Millimetres.*	*Millimetres.*
Lot A	1.53	0.44	10.0	6.5
Lot B	1.00	0.48	9.3	4.7
Lot C	1.32	0.56	7.6	6.7
Lot D	1.54	0.92	7.3	6.0

These data show that in this experiment, where gluten meal was substituted either in part or wholly for corn meal, a larger percentage of fat remained in the buttermilk and the butter was softer than where the corn-meal rations were fed.

Four cows were used in comparing the effects of hay and silage on the butter, the grain ration (corn meal, middlings, and gluten meal) remaining unchanged; hay was fed alone in one period and was largely replaced by silage in the following period. The experiment was carried out in the same manner as the preceding experiment except that the cream was raised by setting the milk in shallow pans. "Hay apparently produced a harder butter than silage," but with regard to churnability the results were at variance.

In a single trial two cows were fed alternately on rations containing 5 pounds of gluten meal or 5 pounds of cotton-seed meal, the basal ration (silage, hay, corn meal, and middlings) remaining unchanged. The average hardness of the butter (penetration) was 11.4 mm. where gluten meal was fed as compared with 5.5 mm. where cotton-seed meal was fed, indicating that the feeding of cotton seed meal tends to harden the butter, a fact which was also indicated by experiments at the Texas Station (see Texas Station Bulletin No. 11, or Experiment Station Record, vol. II, p. 296).

The comparison of gluten meal (2½ pounds) with skim milk (21 pounds) was made with two cows, the basal ration consisting during the whole trial of 36 pounds of silage, 4½ pounds of hay, and 2½ pounds each of corn meal and middlings. The cows were fed the gluten-meal ration the first period, the skim-milk ration the second period, and returned to the gluten-meal ration the third period. The buttermilk contained 1.35 per cent of fat when the gluten-meal ration was fed as compared with 0.33 per cent when skim milk was fed. The butter was softer with gluten meal than with skim milk.

The principal indications of these experiments were that gluten meal tends to produce a softer butter than corn meal, cotton-seed meal, or skim milk, and, other things being equal, to decrease the churnability of the fat; and that silage produces a somewhat softer butter than hay.

While in general a softer butter was found to melt at a lower temperature than a hard butter, the authors found "no definite relation

between melting point and actual hardness." Except where skim milk was fed, no influence of the food on the volatile fatty acids can be traced. "The iodine absorption of butter from gluten-meal rations is greater than that of butter from cotton-seed or corn-meal rations, and so far as tried the iodine-absorption number follows very closely the hardness of butter."

EFFECT OF FOOD ON QUANTITY OF MILK, G. H. WHITCHER, B. S. (pp. 10, 11).—These observations were made in connection with the above comparison of the effect of gluten meal and corn meal on the butter fat. The nutritive ratio varied in the different rations from 1:5.2 with gluten meal to 1:9 with a like amount of corn meal. The yield of milk by 11 cows on the narrow and wide rations is tabulated. "In almost every case with each of the 11 cows, a change from gluten to corn meal, that is a change from a narrow to a wide nutritive ratio, resulted in a decided falling off in the product, while the reverse change resulted in an equally decided increase." The author believes that for milk production the nutritive ratio should not be much wider than 1 to 6.

New Hampshire Station, Bulletin No. 14, May, 1891 (pp. 8).

SILAGE IN DAIRY FARMING, G. H. WHITCHER, B. S.—This is an argument in favor of the use of silage by dairy farmers in New Hampshire. The advantages claimed for silage are these: (1) More food material can be produced on an acre from corn than from any other of our farm crops; (2) the cost of 100 pounds of dry matter is slightly less in corn than in hay; (3) green food is especially favorable to the production of milk; (4) silage is comparatively convenient and cheap. The author believes that the silo makes the farmer independent of the weather. Late varieties of corn, which produce relatively large amounts of food per acre, can be used for silage, though they would not mature corn in the climate of New Hampshire. The early date at which the silage crop is taken from the land makes it possible to use the same land in grass or winter grain the same year. The cost of harvesting silage corn can be made quite small. An instance is cited of an experiment in which silage was harvested and stored at a cost of 62 cents per ton. For New Hampshire, Sanford corn is recommended as a good variety for silage. Of this, the author thinks 14 to 15 quarts per acre should be used for seed. At the prices for materials and labor in New Hampshire, an independent silo can be built "for $1 per ton of capacity if above 75 tons capacity." If the silo is built in the corner of a barn and farm labor is employed in the construction, the expense can be materially reduced.

New York State Station, Bulletin No. 31 (New Series), May, 1891 (pp. 17).

COMMERCIAL VALUATION OF THE FOOD AND FERTILIZING CONSTITUENTS OF FEEDING MATERIALS, P. COLLIER, PH. D. (pp. 481–497).—An extended popular discussion of the commercial value of the food and fertilizing ingredients of different feeding stuffs as estimated on different bases of valuation, and the relation of these values to the ordinary selling price, together with tabulated average analyses of feeding stuffs, and a statement of the average amounts of food and fertilizing ingredients in dairy products per ton.

New York State Station, Bulletin No. 32 (New Series), June, 1891 (pp. 52).

FERTILIZERS, P. COLLIER, PH. D. (pp. 499–551).—This bulletin is in continuation of the series of popular fertilizer bulletins issued by the station "for the benefit of the farmers of New York State." The present number treats of the different materials used in making commercial fertilizers; the fertilizing materials produced on farms; the fermentation, losses, and care of stable manure; and the influence of kind and age of animals, and of food, on the manure. The bulletin also contains tabulated analyses of 46 samples of commercial fertilizers collected in the State during the fall of 1890; and an extensive compilation of analyses of fertilizing materials and the fertilizing ingredients of farm products, taken from various sources.

New York Cornell Station, Bulletin No. 27, May, 1891 (pp. 14).

THE PRODUCTION AND CARE OF FARM MANURES, I. P. ROBERTS, M. AGR. (pp. 29–42, plate 1, figs. 4).—This work is in continuation of previous investigations as to the loss of fertilizing materials from barnyard manure, published in Bulletin No. 13 of the station (see Experiment Station Record, vol. I, p. 279). The conclusions arrived at in these earlier experiments were as follows:

> The results of one season's trial seem to show that horse manure thrown in a loose pile and subjected to the action of the elements, will lose nearly one half of its valuable fertilizing constituents in the course of 6 months; that mixed horse and cow manure in a compact mass and so placed that all water falling upon it quickly runs through and off, is subjected to a considerable, though not so great a loss; and that no appreciable loss takes place when manure simply dries.

The two experiments here reported were on a larger scale than the previous ones. (1) Two tons of loosely piled horse manure (3,319 pounds excrement and 681 pounds wheat straw) were exposed in a well-drained field from April 25 to September 22, when it was scraped up, weighed, and sampled for analysis. The season was very wet, the rainfall from April to September amounting to 27.66 inches. The total weight and the composition of the horse manure before and after exposure are tabulated.* From these analyses the total amounts of the fertilizing ingredients in the fresh and exposed manure are calculated as follows:

Loss of horse manure by exposure.

	Total weight.	Nitrogen.	Phosphoric acid.	Potash.	Commercial value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Fresh horse manure	4,000	19.60	14.80	36.00	$5.60
The same after exposure for 5 months	1,730	7.79	7.79	8.65	2.12

The total loss was considerably more than in the previous year (42 per cent in 1889 and 62 per cent in 1890), but, as in 1889, the greatest loss fell on the potash.

The greater percentage of loss in this experiment is probably due to a greater degree of firefanging caused by the larger proportion of straw used for bedding.

(2) Five tons of cow manure (9,278 pounds excrement, 422 pounds wheat straw, and 300 pounds plaster) were exposed from March 29 to September 22 in a loose pile in the same manner as the horse manure. From the analyses of the manure before and after exposure the total amounts of the various fertilizing ingredients contained in the 5 tons of manure before and after exposure are calculated as follows:

Loss of cow manure by exposure.

	Total weight.	Nitrogen.	Phosphoric acid.	Potash.	Commercial value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Fresh cow manure	10,000	47	32	48	$11.45
The same after exposure	5,125	28	26	44	8.00

It will thus be seen that the total waste in the cow manure was scarcely half what it was in the horse manure. The fermentation of the cow manure was not sufficient to cause any firefanging at all. It is worthy of note that in this experiment the loss of potash was very slight in comparison with that of the phosphoric acid and nitrogen; in all of our other experiments the heaviest loss has been on the potash.

The author summarizes the losses of manure by leaching and fermentation as shown by the results in 1889 and 1890, as follows:

	Original value per ton.	Loss per ton.
Horse manure in loose pile (1889)	$2.45	$1.03
Horse manure in loose pile (1890)	2.80	1.74
Cow manure in loose pile (1890)	2.29	0.69
Mixed manure thoroughly compacted (1889)	2.38	0.22

Amount of manure produced.—The amount and value of the manure voided daily by cows, horses, sheep, and swine are given. While the composition of manure depends very largely upon the kinds of food eaten, an approximate idea of the value of the manure from liberal feeding may be gained from the following summary:

Relative value of the manure per ton, and the amount produced per animal and per thousand pounds live weight.

	Value per ton.	Value per animal per day.	Value per 1,000 pounds live weight per day.	Value per 1,000 pounds live weight per year.
Horses*	$2.79	$0.044	$0.031	$11.47
Horses†		0.073	0.052	19.12
Cows	2.27	0.093	0.082	29.82
Sheep	4.19	0.015	0.106	38.55
Swine	3.18	0.006	0.047	17.11

* Manure voided while at work not included.

† Total excrement calculated on the basis that three fifths was collected in the stable.

A cheap shelter for barnyard manure is described and illustrated.

New York Cornell Station, Bulletin No. 28, June, 1891 (pp. 19).

EXPERIMENTS IN THE FORCING OF TOMATOES, L. H. BAILEY, M. S. (pp. 45–61, figs. 9).—A report on experiments carried on by the author during two winters. Five forcing houses of different kinds are being used.

Our preference is for a house which was designed for tomatoes, having a two thirds span and the ridge 11 feet from the ground. The house is 20 feet wide and built upon a sharp slope. It follows the lay of the land, running nearly east and west. A north and south house would be preferable, probably, because of the more even distribution of light. The framework is unusually light and the glass is 14 by 24 inches.

The experience of the author favors the liberal application of stable manure. "We grow the plants in rich garden loam, to which is added a fourth or fifth of its bulk of well-rotted manure; and when the plants begin to bear, liquid manure is applied every week, or a top-dressing of manure is given." The effect of applying salt, phosphate of soda, nitrate of soda, nitrate of ammonia, or stable manure is graphically shown to illustrate the superior value of the stable manure for tomatoes grown indoors. Seeds sown August 9 yielded the first fruit December 28, and from plants started November 10 the first fruits were picked May 6. The methods employed by the author for training and watering the plants are described. Experiments in the artificial pollination of tomato plants are cited. Where only a little pollen was applied upon one side of the stigma the fruit was small, one-sided, and with seeds only in the half which received the pollen. On the other hand, when pollen was liberally applied to the whole surface of the stigma, the fruit was large and symmetrical and had all its cells developed and seed-bearing. Methods of obtaining a second crop, notes on yields and varieties, on marketing the crop, and on insect and fungus enemies of the tomato are also given. The white scale (*Aleyrodes vaporariorum*) and a small spotted mite are mentioned as serious pests of the tomatoes at the station.

The results of the author's experience in forcing tomatoes are summed up as follows:

(1) The tomato can be forced for winter bearing to advantage, but it demands close and constant attention.

(2) A tomato house should be very light and warm, and the roof should be at least 5 feet above the beds or benches.

(3) An abundance of sunlight is essential.

(4) The temperature should be about 60° to 65° at night and 70° to 80° during the day, or higher in full sunshine.

(5) House tomatoes demand a rich soil and a liberal supply of fertilizers.

(6) In this latitude house tomatoes bear when 4 to 5 months old.

(7) Tomatoes like brisk bottom heat. They may be grown in large boxes or upon benches; 18-inch-square boxes, placed about a foot apart and containing four plants to the box, afford one of the neatest and best means of growing tomatoes.

(8) Winter tomatoes must be trained. From one to three stems, depending upon the distance apart of the plants, are allowed to grow from each plant. These are trained upon perpendicular or ascending cords. The plants must be pruned as fast as new shoots appear. The heaviest clusters should be supported.

(9) Water may be used more freely early in the growth of the plant than later. Wet the soil thoroughly at each watering rather than water often. When the fruit begins to set, keep the atmosphere dry, especially during the middle of the day.

(10) In midwinter the flowers should be pollinated by hand. This may be done by knocking the pollen from the flowers when the atmosphere is dry and catching it in a spoon or other receptacle, into which the stigma is thrust.

(11) One-sidedness and much of the smallness of house tomatoes appears to be due, at least in part, to insufficient pollination.

(*a*) One-sidedness appears to result from a greater development of seeds upon the large side.

(*b*) This development of seeds is apparently due to the application of the pollen to that side.

(*c*) An abundance of pollen applied over the entire stigmatic surface, by increasing the number of seeds, increases the size of the fruit.

(*d*) The pollen probably stimulates the growth of the fruit, either directly or indirectly, beyond the mere influence of the number of seeds.

(12) The second crop of fruit is obtained by training out a shoot or shoots from the base of old plants, by burying the old plant, or by starting a new seedling crop. The first method appears to be the best.

(13) House tomatoes in this latitude yield about 2 pounds to the square foot. The amount of the first crop does not appear to influence the amount of yield in the second crop from the same plant.

(14) Lorillard, Ignotum, Volunteer, Ithaca, Golden Queen, and Beauty we have found to be good winter tomatoes.

(15) Insect pests are kept in check by fumigating with tobacco, and the spotted mite by Hughes' fir-tree oil. Fungi are controlled by ammoniacal carbonate of copper and Bordeaux mixture.

North Carolina Station, Annual Meteorological Report, 1890 (pp. 77).

ANNUAL REPORT OF THE METEOROLOGICAL DIVISION OF THE STATION FOR 1890, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—This division of the station constitutes the North Carolina weather service. The report includes general statements regarding the work done in 1890; an annual summary of observations, comprising seven

tables compiled from the reports of forty-seven observers; and articles on the climate of North Carolina, tornadoes in North Carolina from 1826 to 1890, the formation and classification of clouds, and the origin of cold waves. The last three articles are reprinted from Bulletins Nos. 72*a*, 72*c*, and 73*b* of the station (see Experiment Station Record, vol. II, pp. 288 and 510). The article on the climate of the State is a preliminary report containing summaries of observations covering periods of from 8 to 19 years, in 11 tables. The following comparative summary of observations for 10 years is taken from the report:

Annual summaries of meteorological observations, 1881–90.

PRESSURE.

[In inches.]

Year.	Mean.	Highest.	Lowest.	Range.
1881	30.07	30.76, Feb., at Norfolk	29.17, Mar., at Norfolk	1.59
1882	30.10	30.86, Jan., at Norfolk	29.28, Feb., at Hatteras	1.58
1883	30.10	30.75, Feb., at Norfolk	29.18, Sept. 1, at Southport	1.57
1884	30.08	30.82, Jan. 27, at Lynchburgh	29.22, April 2, at Norfolk	1.60
1885	30.04	30.81, Jan. 3, at Lynchburgh	29.26, Oct. 29, at Norfolk	1.55
1886	30.05	30.80, Jan., at Lynchburgh	29.03, Jan., at Norfolk	1.77
1887	30.07	30.83, Dec. 1, at Lynchburgh	29.14, Aug. 20, at Hatteras	1.69
1888	30.10	30.79, Jan. 12, at Lynchburgh	29.22, Dec. 17, at Norfolk	1.57
1889	30.08	30.81, Feb. 24, at Lynchburgh	29.19, April 26, at Norfolk	1.62
1890	30.11	30.73, Jan. 28, at Hatteras	29.33, Dec. 17, at Lynchburgh	1.40

TEMPERATURE.

[Degrees F.]

Year.	Mean.	Highest.	Lowest.	Maximum range.	Mean daily range.	Mean maximum.	Mean minimum.
1881	59.7	107, Aug., at Weldon	–2, Jan., at Lynchburgh.	109	....	....	....
1882	60.1	100, July, at Weldon	–6, Dec., at Ore Knob	106	....	....	....
1883	60.1	102, July 23, at Weldon	–6, Jan., at Highlands	108	17.0	74.1	57.1
1884	60.1	100, July 24, at Chapel Hill.	–16, Jan. 6, at Knoxville	116	18.1	70.5	52.4
1885	58.4	100, July 10, at Weldon and Chapel Hill.	1, Feb. 11, at Knoxville	99	17.3	67.2	49.9
1886	58.6	100, July 28, at Reidsville	–12, Jan. 11, at Lenoir	112	18.8	68.7	49.9
1887	59.1	107.1, July 18, at Kitty Hawk.	–4, Jan. 6, at Salem	111	18.1	69.0	50.9
1888	59.4	103, Aug. 2, at Weldon	6, Jan. 19, at Asheville	97	17.6	68.8	51.2
1889	59.4	100, July 10, at Kitty Hawk.	6, Feb. 7, at Asheville	94	17.7	68.2	50.0
1890	60.7	103, June 30, at Cheraw	4, Mar. 4, at Highlands	99	19.5	70.7	51.1

HUMIDITY.

Year.	Mean relative humidity.	Yearly rainfall.	Greatest monthly rainfall.	Least monthly rainfall.
	Per cent.	*Inches.*	*Inches.*	*Inches.*
1881	72.8	49.67	14.29, Dec., at Highlands	0.30, Aug., at Lynchburgh.
1882	75.2	55.50	16.98, Jan., at Knoxville	0.33, Oct., at Wadesborough.
1883	74.3	56.09	16.53, Sept., at Wilmington	0.10, July, at Brevard.
1884	74.8	54.31	14.53, Mar., at Brevard	0.05, Nov., at Flat Rock.
1885	75.6	51.20	12.85, Oct., at Flat Rock	0.75, Sept., at Washwoods.
1886	77.7	51.84	21.12, July, at Wilmington	0.02, Oct., at Kitty Hawk.
1887	73.8	52.09	22.73, Aug., at Tarboro	0.12, Nov., at Lincolnton.
1888	76.5	54.98	13.99, May, at Marion	0.27, April, at Washwoods.
1889	75.6	50.73	14.04, Suly, at Fayetteville	0.10, Dec., at Southport.
1890	75.2	46.49	14.48, July, at Highland	0.00, Nov., at Lenoir.

Annual summaries of meteorological observations, 1881–90—Continued.

WIND.

Year.	Movement per month.	Average hourly velocity.	Maximum velocity.	Prevailing direction.
	Miles	*Miles.*	*Miles.*	
1881	6,422	8.8	76, N. E., April 14, at Kitty Hawk	N. E.
1882	6,704	9.2	72, N., Dec. 30, at Hatteras	S. W.
1883	6,596	9.0	93, S. E., Sept. 11, at Southport	N. E. and S. W.
1884	5,987	8.2	68, S. E., Jan. 8, at Fort Macon	N. E.
1885	6,086	8.3	98, S. W., Aug. 25, at Kitty Hawk	S. W.
1886	5,876	8.0	56, N., May 1, at Kitty Hawk	S. W.
1887	4,823	6.6	82, S. E., Aug. 20, at Hatteras	S. W.
1888	4,900	6.7	66, N., Nov. 25, at Hatteras	S. W.
1889	5,277	7.2	84, E., Mar. 19, at Kitty Hawk	S. W.
1890	5,491	7.4	63, N. E., Sept. 29, at Kitty Hawk	S. W.

WEATHER.

Year.	No. clear days.	No. fair days.	No. cloudy days.	No. rainy days.
1881	......	......	......	125
1882	110	155	100	145
1883	109	161	95	133
1884	119	150	97	136
1885	124	152	89	138
1886	125	148	92	127
1887	126	143	96	130
1888	129	122	115	121
1889	132	112	121	113
1890	135	125	105	107

Ohio Station, Bulletin Vol. IV, No. 1 (Second Series), January, 1891 (pp. 38).

EXPERIMENTS WITH CORN, C. E. THORNE AND J. F. HICKMAN, M. S. A.—This article reports in detail the experiments with corn conducted by the station in 1890, together with summaries of similar experiments in previous years. The subjects treated are, (1) tests of varieties; (2) distribution of seed; (3) planting of seed from different parts of the ear; (4) deep *vs.* shallow cultivation; (5) methods of harvesting; (6) tests of varieties of silage corn; and (7) field experiments with fertilizers at the station and elsewhere in Ohio. Previous accounts of experiments with corn may be found in the Annual Report for 1888 and in Bulletins vol. III, Nos. 2 and 3, of the station (see Experiment Station Bulletin No. 2, part II, p. 113, and Experiment Station Record, vol. II, pp. 121 and 165). "The season of 1890 was peculiarly unfavorable to corn, the almost incessant rains of spring and early summer interfering seriously with planting and cultivation, after which a severe drouth retarded growth." The average yield per acre in the test of varieties in 1889 was 69.5 bushels, while in 1890 it was only 57.6 bushels.

Corn, test of varieties (pp. 3–17).—The test of varieties at the station in 1890 was conducted on tenth-acre plats on fertile river bottom land. The stand obtained from the first planting (May 29) was so poor that

replanting (June 12) was necessary. Tabulated data for 38 varieties of dent corn (classified as large and medium yellow, mixed, and large and medium white) and for Brazilian Flour corn, include weight when husked, number of ears, shrinkage in drying, weight of shelled corn and of cobs, color of cob, yield per acre of grain and stalks, date of cutting, number of days from planting to cutting, and state of maturity. Data are also given for duplicate tests with four varieties in three counties representing different sections of the State. Other tables give averages of yields, etc., for the classes of varieties indicated above, and for 11 varieties for each of 3 years (1888–90), including the average yield as weighed in November and again in January. The per cent of shrinkage varied from 7 to 25. The rainfall and mean temperature at the station in each of 5 months (April-August) in 8 different years (1883–90) are also given. The total average rainfall during the 8 years was 17.48 inches, and the mean temperature 64.7° F. Brief descriptive notes are given for 33 varieties.

Corn, distribution of seed (pp. 17, 18).—Tabulated results of planting kernels from 9 to 49 inches apart and dropping from 1 to 4 grains at a time. The average yields for 3 years have been, with kernels 12 inches apart, 79.7 bushels per acre; 15 inches, 64.9 bushels; and 18 inches, 64.4 bushels. From planting at 6 inches apart in 1888 and 1889 an average yield of 101.9 bushels per acre was obtained, but nearly half (47 per cent) of these were nubbins.

Corn, seed from different parts of the ear (pp. 18–20).—"The seed used in this experiment has been grown continuously from the several parts of the ear, each year preserving the seed from the tips of ears grown from planting tips the year previous, middles from middles, and butts from butts, in like manner for three consecutive seasons [1888–90]." Results are tabulated for 1890 and for three other years (1886, 1888, and 1889) in which similar experiments were made. The average yields for the 4 years were, from the butts 66.9, middles 62.8, tips 64.8 bushels per acre.

Corn, deep vs. shallow cultivation (pp. 20, 21).—The average results of experiments in 1890 with deep and shallow cultivation, as given in a table, show a slight advantage in favor of the latter method. Similar experiments in 1888 and 1889 slightly favored the former method.

Corn, methods of harvesting (pp. 21–24).—Experiments at this station and in three other places in Ohio are reported, in which the corn on some of the experimental plats was cut and shocked in the ordinary way and at the ordinary season; on others it was topped; and on others it was allowed to mature on the stalk. The results, as tabulated, are contradictory.

Corn, test of varieties for silage (pp. 24, 25).—The yields are given for nine varieties grown on fertile soil in 1889, and on poor soil in 1890. The corn was planted June 7 and 19, and was cut September 27. "In neither year were the varieties of corn sufficiently matured to make

first-class silage, except the Early Sanford, and this variety is not sufficiently productive to justify its general introduction for silage purposes."

Corn, field experiments with fertilizers (pp. 25–37).—A report on experiments in 1890 at the station and by three farmers in as many counties of the State. The plan followed was in general that described in Bulletin vol. III, No. 2, of the station (see Experiment Station Record, vol. II, p. 122). The results are stated in tables, and compared with those of 1889. In every case where barnyard manure was used, there was an increase of from 2.9 to 26.4 bushels in the yield. The results from the use of superphosphate, muriate of potash, and nitrate of soda, singly and in combination, were quite variable, and in general confirmed the tentative conclusions drawn from the previous experiments. Valuing corn at an average of 33⅓ cents per bushel, the increase in yield due to the use of fertilizers was not sufficient to pay their cost in any of the tests of 1890.

Corn, summary of experiments (pp. 37, 38).—The following statements are taken from the summary given in the bulletin:

(1) From the large yellow dent class, only a few are recommended for Ohio soil, namely, Big Buckeye, Leaming, Leaming Improved, Murdock Yellow Dent, and Woodworth Yellow Dent. From these the Leaming or Leaming Improved might be selected as the most prolific. The Clarage from among the medium dents and the Butcher corn from the mixed dents, are both good varieties and will mature in an ordinary season. Briar Crest Beauty, Chester County Mammoth, Golden Beauty, Golden Dent, and Cloud Early Dent are large and productive varieties, but can not be relied upon to mature on Ohio soils. Golden Dent and Golden Beauty are believed to be one and the same variety. * * *

(2) The results of previous experiments are confirmed by the work of this year, in showing that more and better corn can be raised to the acre where the stalks average 12 inches apart than where they are at less or greater distances. The results in general are as good when the corn is planted in hills as when planted in drills, when the average distances of the grains or stalks are the same.

(3) The results of a 4 years' comparative test fail to show any marked superiority in the productiveness of seed taken from the butt, middle, or tip of the ear.

(4) The results of 2 years' experiments are slightly in favor of shallow culture.

(5) The exact stage of maturity at which corn is cut may materially affect its final yield per acre.

(6) Red Cob Ensilage, Blount White Prolific, and B. and W. are good varieties for the silo. Early Sanford and sweet fodder corn are not as a rule profitable in this State for silo purposes. * * *

(7) The results of 2 years' experiments, conducted on the station farm and in various sections of the State, indicate that in Ohio the use of commercial fertilizers on corn, at present prices of grain and fertilizers, is likely to result in loss more often than in profit.

Ohio Station, Bulletin Vol. IV, No. 2 (Second Series), February, 1891 (pp. 19).

MISCELLANEOUS EXPERIMENTS IN THE CONTROL OF INJURIOUS INSECTS, C. M. WEED, D. Sc. (pp. 39–47).—Brief accounts of experiments, (1) by the author with Bordeaux mixture combined with Paris green or London purple, and with ammoniated carbonate of copper and

Paris green, in which no injury was done to the foliage of fruit trees, grapevines, or potatoes; (2) by the author with Paris green, London purple, or lime and London purple applied to pear and apple trees, in which it appeared that Paris green did little injury to foliage; London purple alone did much injury, but this was largely prevented by the addition of lime to the solution of London purple; (3) by two Ohio fruit growers with London purple for the plum curculio, in which injuries by the insect were largely prevented, but the foliage was considerably damaged; (4) by three Ohio fruit growers with dilute whitewash for the rose chafer (*Macrodactylus subspinosus*), with varying success; (5) by several farmers with various remedies for the striped cucumber beetle (*Diabrotica vittata*); (6) by the author with tobacco powder used successfully for plant lice on lettuce.

SOME COMMON CABBAGE INSECTS, C. M. WEED, D. SC. (pp. 47–52, figs. 6).—Notes on the imported cabbage worm (*Pieris rapæ*), cabbage plusia (*Plusia brassicæ*), zebra caterpillar (*Ceramica picta*), wavy-striped flea beetle (*Phyllotreta vittata*), and cabbage cutworms, with illustrations after Riley.

THREE IMPORTANT CLOVER INSECTS, C. M. WEED, D. SC. (pp. 53–55, figs. 3).—Notes on the clover root borer (*Hylastes trifolii*), clover seed midge (*Cecidomyia leguminicola*), and clover hay worm (*Asopia costalis*), with illustrations after Riley.

Texas Station, Bulletin No. 14, March, 1891 (pp. 15).

EFFECTS OF COTTON SEED AND COTTON-SEED MEAL ON THE CREAMING OF MILK, G. W. CURTIS, M. S. A., AND J. W. CARSON (pp. 61–73).—The following experiments were made to study the effect of cotton seed or cotton-seed meal when fed to milch cows, on the completeness of the separation of the cream. This effect was studied in cases where the cream was raised by setting the milk in Fairlamb cans at 70° or at 45° F., and where the creaming was effected by a De Laval separator, each test being made with cows somewhat advanced in the milking period and with others comparatively new milch. "The selections of cows were made with special reference to length of time since calving and to uniform individual quality as determined by previous test. * * * Each animal was carefully watched throughout the entire test, and at once withdrawn on the appearance of the least abnormal indication, whether of appetite, general health, or condition."

Three separate experiments were made in which the milk was set, as soon as milked, in Fairlamb cans, without ice, and kept as nearly as possible at a temperature of 70° F. until sour (12 to 24 hours), when it was skimmed. Each of these experiments represented a different stage of the lactation period. Thus the 10 cows in the first experiment had calved 104 to 124 days, the 8 in the second experiment 88 to 93 days, and the 6 in the third experiment 49 to 51 days previous to the beginning of the trial. In each experiment the cows were divided

into two lots as nearly equal as possible, and while those of one lot received equal parts of corn and-cob meal and bran, those of the other received equal parts of cotton-seed meal and bran. The coarse fodder was the same for both lots in each experiment and consisted variously of hay and pasturage, silage, or silage, pasturage and sorghum. The amounts of food given and the duration of the experiments are not stated. The milk for each lot was mixed and set by itself. After the feeding had been continued for 12 days, samples of the whole milk and skim milk were taken for analysis. The fat in the whole milk was determined by the Patrick milk test, and that in the skim milk by the Adams gravimetric method. The results of these analyses, and the percentage of the total fat which was left in the skim milk, are tabulated for each lot in each experiment. The averages of these results are given below:

Milk set in cans at 70° F.

	Number of days since last calving.	Without cotton-seed meal.			With cotton-seed meal.		
		Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.	Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
First experiment	104–124	5.22	1.63	30.9	5.89	1.10	18.4
Second experiment	88–93	4.08	1.28	31.8	3.98	0.91	22.9
Third experiment	49–51	4.40	0.64	14.9	4.18	0.47	11.3

As will be seen, the separation of the fat by setting at 70° F. was more complete from the milk of the cows receiving cotton-seed meal than from that of those receiving corn-and-cob meal. "That the effect is in no sense due to individual peculiarity of cows, is proven, we think, satisfactorily by the fact that different sets of cows were used in the tests represented by each separate table, as above given, the food condition showing itself uniformly the same with different sets."

Three other trials were made, in which the milk was set in cans at 45° F., this temperature being maintained by the use of ice costing 1 cent per pound. In the first two trials the same 10 cows were used, the milk being skimmed in one experiment after 12 hours and in the other after 24 hours' setting. The third experiment was with 8 cows nearly fresh in milk, and the skimming took place after 24 hours' setting. In each experiment the cows were divided into two lots, one lot receiving equal parts of corn meal and bran, while the other received equal parts of cotton-seed meal and bran. The coarse fodder consisted in all cases of silage and pasturage.

The averages of the results stated are as follows:

Milk set in cans at 45° F.

	No of days since last calving	Without cotton seed meal.			With cotton seed meal		
		Fat in whole milk.	Fat in skim milk	Per cent of total fat left in skim milk.	Fat in whole milk.	Fat in skim milk	Per cent of total fat left in skim milk.
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Skimmed after 12 hours	125–145	4 22	2 07	49.1	4.34	1.38	31 7
Skimmed after 24 hours	132–152	4 34	1 67	37 0	4 86	1 11	22 9
Skimmed after 24 hours	30– 34	4.53	0 96	21.3	4.27	0.34	7.9

Here again the percentage of fat left in the skim milk was least with the cows receiving the cotton-seed-meal ration. The separation of the cream was in all cases more complete with 24 hours' setting than with 12 hours.

The results of both series of experiments indicate further that the separation of cream by setting milk in cans was less perfect when the cows were advanced in the lactation period than when they were nearly fresh. The influence of the stage of the milking period in this respect was very marked, whether the food contained cotton-seed meal or not. The results indicate no particular advantage of setting at 45° over 70°.

From the results of an experiment with 4 new milch cows, made to compare the effects of cotton seed with those previously observed for cotton-seed meal on cows likewise new milch, the authors conclude that "there is practically no difference between the effects of cotton seed and cotton-seed meal so far as gravity creaming is concerned."

To determine whether cotton-seed meal has any effect on the separation of the cream by means of the centrifugal apparatus, 8 cows were fed the corn-meal-and bran ration, and 8 others, at the same stage of lactation, the cotton-seed-meal-and-bran ration. The milk of these cows was separated by a De Laval power separator as soon as milked. The average results were as follows:

Cream separated centrifugally.

	No of days since last calving	Without cotton seed meal.			With cotton seed meal		
		Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.	Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
I	210	4 67	0.08	1.8	4 39	0.10	2 3
II	50–63	3.88	0.13	3.27	3 84	0 13	3.3

"It will be seen that there is really no difference in machine creaming due to food effect."

Utah Station, Bulletin No. 6, May 15, 1891 (pp 14).

TRIALS OF SLEDS AND TILLAGE TOOLS, J. W. SANBORN, B. S.—Notes and tabulated data on tests of various kinds of sleds and harrows with the dynamometer and in other ways. The following summary is taken from the bulletin:

(1) In the trial made, sleds drew harder than wagons over the same ground the previous fall under what seemed to be equally favorable conditions for each.

(2) Change of load from the front to the rear end of the sled did not materially affect draft, as it did with wagons.

(3) The friction due to the point of hitch of the horses or the relation of the power to the load did not follow the same law as with wheels. The hitch for sleds seems to be too low down as now made.

(4) A load draws as easy with crooked shaft as with a straight hitch.

(5) Draft varied with the sleds used and was least on the shortest sled, but it is not certain that the length of sled was the determining cause in the trials made. No other solution of the facts found was discovered. Future inquiry will be necessary to determine with certainty the cause of the variations in draft between the makes of sleds used.

(6) Depth of cutting the ground, draft per square inch and per pound of soil moved, looseness of soil, and evenness of bottom varied very widely in the various types of harrows used.

(7) The rolling cutters, especially those termed cutaway harrows, move the soil deepest and loosen it most, and in the form of the cutaway harrow draw the easiest of the class that penetrates deeply.

(8) The spring-toothed harrows draw moderately "fine" to an average degree, and till to an average depth, but leave the soil with an uneven bottom and more compact than the class above named, while on newly plowed grass sward they tear up the sod. For the cultivation of corn, they are very good implements, serving well the functions required in tillage of crops.

(9) The square-toothed and the smoothing harrows are superficial in their action on plowed ground, run easy, but compress the soil more than other classes, and are therefore better adapted to loose soils and for putting in seeds than to do the tillage work of soil fitting for crops. If present views regarding tillage are correct, then these implements are utterly unfitted for the purpose when applied to most soils.

(10) When depth of cutting, ease of draft, evenness of bottom or of the top of the unstirred soil, and looseness of soil are considered, the cutaway type of harrows is the best of the several classes of tillage tools used by the writer for the preparation of the average soil for crops. It is believed that the work of this class of harrows should always be supplemented by the smoothing harrow.

(11) Harrows move less earth for a given amount of force than plows do, but, as found in a previous trial, the force required for fitting the soil for crops, when the plow supplemented by the harrow, is used is practically no less than when the harrow alone is used.

(12) Less force is required to fit a given surface area of soil for crops when the harrow is used than when the plow is used. This fact admits of the use of some substitute for the plow upon soils that do not require deep tillage, if, indeed, there are such soils.

(13) The relative efficiency of harrows varies on varying soils and on varying conditions of a given soil, the wedge-shaped teeth being at greatest disadvantage on hard soils.

(14) The plow, acting as a wedge, compresses the particles nearer together as it inverts the soil and divides only large masses; therefore the harrow is the true implement for "fining" and loosening the soil, the plowing serving to fit the soil for its

action. Except upon grass ground, it is not improbable that the harrow, somewhat modified, may grow in importance when compared with the plow, unless the plow becomes modified for special soils.

Vermont Station, Bulletin No. 24, May, 1891 (pp. 16).

POTATO BLIGHT AND ROT, L. R. JONES, B. S. (pp. 19–32).—Brief accounts of successful experiments in spraying potato vines with Bordeaux mixture for potato rot (*Phytophthora infestans*). In one experiment in 1890 a plat which was sprayed twice yielded 165 bushels of sound tubers, another sprayed once yielded 155 bushels, while a third plat twice as large as either of the other two, which was left unsprayed, yielded only 86 bushels. It was found feasible and desirable to combine the Bordeaux mixture with the Paris green used for potato bugs. Attempts were made to disinfect tubers before planting by heating them for a number of hours in a dry oven at 107½° to 109½° F., in sealed jars at 106° to 108° F., or by soaking them in water at 106° to 108° F., or in solutions of sulphate of copper. The heating in a dry oven seems to have been beneficial, but the other treatments were more or less injurious. Examinations of samples of a number of varieties of potatoes showed that in these cases the dry rot was worse at the seed end than at the stem end. Details of the investigations on potato rot will be published in the Annual Report of the station for 1890.

Vermont Station, Bulletin No. 25 (pp. 4).

THE BOUNTY ON MAPLE SUGAR, W. W. COOKE, M. A. (pp. 33–36).—An explanation of the conditions under which the farmer can secure the bounty for maple sugar offered by the national Government in accordance with a recent act of Congress. Tests made at the station indicate that most of the sugar made in the State during the early and middle parts of the season will test over 80 degrees by the polariscope, and thus come up to the standard required by the law. The station is making investigations with reference to methods of making maple sugar, and will publish the results in a future bulletin.

West Virginia Station, Bulletin No. 13, January, 1891 (pp. 63).

THE CREAMERY INDUSTRY, J. A. MYERS, PH. D. (plates 1, figs. 6).—A reprint of an article on this subject published in the Annual Report of the station for 1890, pp. 29–88, an abstract of which was given in Experiment Station Record, vol. III, p. 44.

West Virginia Station, Bulletin No. 14, February, 1891 (pp. 17).

FARM AND GARDEN INSECTS AND NOTES OF THE SEASON, A. D. HOPKINS (pp. 65–79).—This is a reprint of articles published in the Annual Report of the station for 1890, pp. 145–159 (see Experiment Station Record, vol. III, p. 46).

West Virginia Station, Bulletin No. 15, March, 1891 (pp. 6).

RASPBERRY GOUTY GALL BEETLE, A. D. HOPKINS (pp. 81–84, plate 1).—A reprint of notes on *Agrilus ruficollis* published in the Annual Report of the station for 1890, pp. 160–163 (see Experiment Station Record, vol. III, p. 46).

West Virginia Station, Bulletin No. 16, April, 1891 (pp. 11).

LOCUST TREE INSECTS, A. D. HOPKINS (pp. 85–91, plate 1).—A reprint of an article published in the Annual Report of the station for 1890, pp. 164–170 (see Experiment Station Record, vol. III, p. 47).

West Virginia Station, Bulletin No. 17, May, 1891 (pp. 12).

PRELIMINARY REPORT ON BLACK SPRUCE INSECTS, A. D. HOPKINS (pp. 93–102).—A reprint of an article published in the Annual Report of the station for 1890, pp. 171–180 (see Experiment Station Record, vol. III, p. 47).

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF BOTANY.

CONTRIBUTIONS FROM THE U. S. NATIONAL HERBARIUM, VOL. I, No. 4, JUNE 30, 1891.

LIST OF PLANTS COLLECTED IN WESTERN MEXICO AND ARIZONA, J. N. ROSE (pp. 91–127, plates 10).—This includes lists of plants collected by Dr. Edward Palmer in western Mexico (at Alamos) and Arizona in 1890, with descriptive notes on 45 new species and several new varieties. The new species illustrated in the plates accompanying the bulletin are, *Stellaria montana*, *Diphysa racemosa*, *Echinopepon cirrhopedunculatus*, *Tithonia fruticosa*, *Bidens alamosanum*, *Hymenatherum anomalum*, *Perezia montana*, *Cordia sonoræ*, *Ipomœa alata*, and *Tabebuia palmeri*.

Among the plants of this collection are many very beautiful ones which should claim the attention of cultivators. Of these we cite *Heteropterys portillana*, a recent species described by Mr. Watson. This is especially attractive for its large clusters of red fruit. It is very common at Alamos, and could easily be obtained for cultivation.

Galphimia humboldtiana, a rare plant in herbaria, is a common and attractive shrub of the mountains here. It is 6 to 8 feet high, with a handsome top, large racemes of yellow flowers, and attractive foliage.

Cordia sonoræ is a new species, a very beautiful shrub or small tree, and an abundant bloomer.

Tabebuia palmeri, another new species, is a conspicuous tree of this region. It grows to the height of 25 feet and produces large clusters of flowers.

Three or four of the Ipomœas are very attractive; one is a tree 30 feet high; another is a climbing shrub (*I. bracteata*), with large, conspicuous bracts, which give the plant a very showy appearance; two other new species are high-climbing vines.

CONTRIBUTIONS FROM THE U. S. NATIONAL HERBARIUM, VOL. II, No. 1, JUNE 27, 1891.

MANUAL OF THE PHANEROGAMS AND PTERIDOPHYTES OF WESTERN TEXAS, POLYPETALÆ, J. M. COULTER (pp. 156, plate 1).—This is the first part of a manual intended to include descriptions of all Texan plants west of the ninety-seventh meridian. The rich flora of this region has never before been systematically described. It is believed that the manual will be of service to botanists and students not only

in Texas, but also in other large regions of the Southwest, which have a more or less similar flora. As far as practicable, the geographical range of the different species is indicated. This part, which embraces only the Polypetalæ, contains descriptions of 765 species in 271 genera belonging to 50 orders. The great orders are the Leguminosæ, represented by 203 species in 52 genera; Cactaceæ, 71 species in 4 genera; Malvaceæ, 53 species in 14 genera; Umbelliferæ, 50 species in 29 genera; Cruciferæ, 48 species in 18 genera; Onagrarieæ, 38 species in 6 genera; Rosaceæ, 28 species in 13 genera. The single plate accompanying this bulletin illustrates *Thelypodium vaseyi*, Coulter.

DIVISION OF FORESTRY.

BULLETIN NO. 5.

WHAT IS FORESTRY? B. E. FERNOW (pp. 52).—This is a popular statement of the general principles of forestry, taken mainly from addresses delivered by the author before representative bodies. The subject is treated in three chapters, viz: The Forest and its Significance, Forestry in a Wooded Country or Forestry Management, and Forest Planting in a Treeless Country. The topics considered under forestry in a wooded country are: The objects of forest management, where forest growth should be maintained, what forest management is and what it is not, reproduction of trees, improvement of tree crop—thinning, undergrowth, mixed growth—light influences, special considerations in thinning, European government forestry, administrative considerations, working plans, and profitableness of forest management. The author takes a conservative view of the methods which should be immediately adopted in this country for the management of our forests.

Forestry in a wooded country means harvesting the wood crop in such a manner that the forest will reproduce itself in the same if not in superior composition of kinds. Reproduction then is the aim of the forest manager, and the difference between the work of the lumber man and that of the forester consists mainly in this: That the forester cuts his trees with a view of securing valuable reproduction, while the lumberman cuts without this view, or at least without the knowledge as to how this reproduction can be secured and directed at will. * * *

The administrative measures in vogue in European forest management we may perhaps not think desirable or suitable to our country and conditions, but the technical measures, as far as they are based upon natural laws and by experience proved proper for the object in view, will have to be adopted, with the necessary modifications, if we wish to attain proper forest management.

However, before we may apply the finer methods of forestry management as practiced abroad, it will be well enough to begin with common-sense management, which consists in avoiding unnecessary waste, protecting against fire, keeping out cattle where young growth is to be fostered, and not preventing by malpractice the natural reforestation.

The financial side of forestry abroad is illustrated in the following table. The marked differences in expenditures and revenues are stated

to be due "to differences of market facilities and intensity of management, and also to forest conditions:"

Countries.	Forest area.	Total expenditure.	Revenue.		Expenditures and revenues per acre of forest.						
					Expenditures.						
			Gross.	Net.	Total.	Gross income.	Administration and protection.	Marketing crop.	Cultivation.	Roads.	Net revenue.
	Acres.					*Per ct.*					
Prussia	6,000,000	$8,000,000	$14,000,000	$6,000,000	$1.33	58	$0.48	$0 30	$0 14	$0.06	$0.96
Bavaria	2,300,000	3,150,000	5,880,000	2,730,000	1.37	53	0.64	0.37	0.11	0.11	1.19
Württemberg ..	470,000	1,025,000	2,260,000	1,235,000	2.17	45	0.87	0,92	0.22	0.23	2.63
Saxony..........	416,000	1,040,000	2,750,000	1,710,500	2.50	37	0.65	0.81	0.11	0.21	4.11
Baden...........	235,000	404,000	1,090,000	686,000	1.54	40	0.22	0.83	0.15	0.12	2.90
City of Zurich ...	2,760	14,000	26,000	12,000	5.00	54	1.14	2.10	0.16	1.14	4.40

In the chapter on forest planting in a treeless country, the topics considered are, forest cover and moisture, need of coöperative action, how to plant, relation of tree growth to light, how to mix species of trees, conifers, methods of planting, and forest planting as a work of internal improvement. The general principles on which experiments in tree planting on the plains should be made are summed up as follows:

(1) Forest plantations in large blocks have more chance of success than small clumps or single trees, since large plantations alone are capable of becoming self-sustaining and of improving their conditions of growth by their own influence upon moisture conditions of the soil and air.

(2) We must not only plant densely (much more densely than is the common practice), but in the selection of kinds give predominance to such as are capable of quickly and persistently shading the ground, creating an undergrowth and cover that will prevent evaporation, and thus make possible the planting of the light-foliaged, quick-growing, valuable timbers.

Twelve kinds of trees used in prairie planting are grouped as follows, according to their shade endurance, and their rate of height growth during their youth:

As to shade.	*As to rate of height growth.*
(1) Box elder.	(1) Cottonwood.
(2) Mulberry.	(2) Soft maple.
(3) Elm.	(3) Elm.
(4) Black cherry.	(4) Locust.
(5) Osage orange.	(5) Honey locust.
(6) Catalpa.	(6) Black cherry.
(7) Soft maple.	(7) Catalpa.
(8) Locust.	(8) Osage orange.
(9) Honey locust.	(9) Box elder.
(10) Black walnut.	(10) Black walnut.
(11) Ash.	(11) Ash.
(12) Cottonwood.	(12) Mulberry (?).

This is not an immutable scale, but only a tentative proposition, and for the purpose of illustration, in which the kinds placed widely apart will alone really retain their relative positions. We will find at the top of the first scale the most shade enduring and at the head of the second scale the most rapid growing among those named. If we can make, therefore, a combination of these, we will succeed in obtaining the two points to be gained—the densest crown cover in varying tiers, and the light-needing kinds overgrowing the shade-enduring, which allows the largest number of individuals on the area. * * *

Of all trees, the most suitable for prairie planting and for planting in the dry plains are beyond doubt the conifers, especially the pines.

There are two reasons why they should be chosen preferably to others: First of all, they furnish not only a denser cover, lateral and vertical, but a cover all the year around, being evergreen. Secondly, they require less water, from one sixth to one tenth, than most deciduous trees, and are therefore less liable to succumb to drouth. In winter they will hold the snow more efficiently than the naked, leafless kind, thus preserving the moisture on the ground.

Nature has given us indications in that direction. The driest soils everywhere are occupied by the pines, and the arid slopes of the Rocky Mountains and the interior basin support only conifers, especially pines and junipers. From Professor Bessey I learned only to-day that my theory regarding the former forest cover of the plains is borne out by the discovery of pine forests buried in the sand hills of northern Nebraska; and that he found growing naturally in eastern Nebraska the same kind of pine that covers the Black Hills and Rocky Mountain slopes, namely, the bull pine (*Pinus ponderosa*).

Articles setting forth the results of personal experiences in tree planting on the Dakota plains are appended to the bulletin, the authors being A. M. Thomson and J. W. Smith.

OFFICE OF EXPERIMENT STATIONS.

Experiment Station Bulletin No. 2, Part II.

Digest of the Annual Reports of the Agricultural Experiment Stations in the United States for 1888 (pp. 173).—This contains a digest of the reports of the stations in Kansas, Kentucky, Maine, Maryland, Minnesota, New Hampshire, Ohio, Pennsylvania, Rhode Island, South Carolina (part II), and West Virginia, which reports were not received by the Office until after the publication of part I of this bulletin. Separate indexes of names and subjects accompany each part of the digest.

Miscellaneous Bulletin No. 3.

Proceedings of the Convention of American Agricultural Colleges and Experiment Stations at Champaign, Illinois, November, 1890 (pp. 156).—This is edited by A. W. Harris for this Office, and H. E. Alvord for the Association. Besides minutes of the general and sectional sessions, the papers read are given in full or by abstracts. For a brief account of the convention, with the titles of papers, see Experiment Station Record, vol. II, p. 265.

DIVISION OF GARDENS AND GROUNDS.

PAPERS ON HORTICULTURAL AND KINDRED SUBJECTS, W. SAUNDERS (pp. 124).—These are reprinted from reports of the Department of Agriculture, 1863–89, and include articles on the following subjects: Landscape gardening, draining lands, sowing seeds and raising young plants of forest trees, making and keeping lawns, spring and fall planting of trees, keeping hedges, cultivation, mechanical preparation of soil, mulching, situations for orchards, orchard planting, management of orchards, pruning, remarks on pear culture, native grapes, grapes—mildew, propagating native grapes, foreign grapes in glass structures, inside borders for graperies, thrips on grapes, propagating by cuttings, sowing seeds, seed saving, rotation in cropping, expedients for promoting fruitfulness in plants, importance of a uniform supply of water in plant culture, liquid manure for plants in pot culture, flower pots, night temperature in glass structures, watering plants in pots, water plants, glazing greenhouse roofs, raspberry culture, figs, vanilla, India rubber plants, citron, special inquiries and answers, well-ripened wood, and notes on orange culture and the pineapple.

DIVISION OF STATISTICS.

REPORT NO. 86 (NEW SERIES), JULY, 1891 (pp. 303–374).—This includes articles on the condition and acreage of corn, wheat, oats, rye, barley, cotton, potatoes, tobacco, grasses, and fruit, July 1, 1891; the weight of wool per fleece; reports of State agents; European crop report for July; European rye production; the coöperative credit unions or people's banks of Germany; agriculture in Peru; and transportation rates.

Rye in Europe is a cereal second in importance to wheat only. In many countries it is the staple breadstuff, its use making possible a larger exportation of wheat from exporting countries, and supplementing the higher-priced cereal in importing countries. In eastern Europe the product is larger than the wheat crop in Austria, Germany, and Russia. The crop in Russia is larger than any cereal crop grown in any country of the world, except corn in the United States.

The rye crop of Europe.

[In Winchester bushels.]

Countries.	1887.	1888.	1889.
Austria-Hungary:			
Austria	91, 031, 114	81, 570, 776	70, 780, 876
Hungary	51, 295, 798	42, 195, 395	36, 789, [illegible]
Belgium	18, 182, 505	15, 047, 047	18, 117, [illegible]
Denmark	16, 690, 138	15, 685, 483	17, 329, 012
France	67, 182, 673	62, 957, 945	65, 622, 312
Germany	250, 908, 981	217, 418, 451	211, 146, [illegible]
Ireland	232, 686	374, 104	406, 570
Italy	4, 330, 791	3, 648, 835	3, 831, 956
Netherlands	13, 776, 063	....	....
Portugal	....	....	6, 437, 340
Roumania	....	....	10, 305, 431
Russia in Europe, except Poland	744, 192, 075	706, 646, 588	551, 525, 600
Poland	....	47, 887, 247	37, 500, 783
Servia	....	2, 600, 000	....
Spain	....	....	24, 303, 155
Sweden	22, 405, 845	19, 955, 286	20, 924, 576

FIBER INVESTIGATIONS, REPORT NO. 3.

SISAL HEMP CULTURE, C. R. DODGE (pp. 59, plates 8, figs. 21).—This includes a brief history of the culture of sisal hemp in Florida; notes on the soil, climate, and cultivation adapted to these plants, and on rate of growth, harvesting, and yield per acre; descriptions of machinery for extracting the fiber; an account of the present condition of the industry in Florida; notes on other leaf fibers (*Agave americana*, *A. mexicana*, and *Sanseviera zeylanica*) observed by the author in Florida; compiled notes on *Agava rigida*, var. *sisalana*, and on the sisal hemp industry in the Bahamas.

The imports of sisal hemp fiber into this country from Yucatan for the fiscal year ending June 30, 1890, amounted to 28,312 tons, in round numbers, worth $4,330,300; and for the year previous the imports amounted to over 35,000 tons. This does not take into account the imported manufactures from sisal hemp, which are considerable, the value of which can not be given. It is said that the United States purchases over 80 per cent of the marketable fiber produced in Mexico.

The fact that the sisal hemp plant can be grown in this country in any quantity, as far as the mere question of cultivation is concerned, was satisfactorily demonstrated many years ago. Over 50 years have passed since the plant was introduced into Florida by Dr. Henry Perrine, and it is now growing wild in many portions of the State.

Sisal hemp is now extensively grown in Mexico and has been successfully introduced into Cuba and the Bahamas. There is reason to believe that it can be profitably grown in southern Florida.

A rapid method for estimating nitrates in potable waters, George Harrow (*Jour. Chem. Soc.*, 59, *pp.* 320–323).—The author sought to devise a method for the estimation of nitrates which should be as rapid as Nessler's test is for the determination of ammonia. The method which he proposes depends on the conversion of nitric acid into nitrous acid by means of zinc dust, and the estimation of the nitrous acid by the Griess test (α-napthylamine and sulphanilic acid). The test reagent is prepared by dissolving 1 gram α-napthylamine, 1 gram sulphanilic acid, and 25 c. c. strong hydrochloric acid, in about 200 c. c. of distilled water, boiling with a small quantity of animal charcoal, filtering, and then making up to 500 c. c. Standard solutions containing respectively 1, 0.1, and 0.01 part of nitrogen as nitrates per 100,000 are made by dissolving 0.721 gram of pure dry potassium nitrate in 1 liter of water (=10 parts of nitrogen per 100,000 c. c.), and diluting to the required strength.

The manner of making the test is described as follows: Fifty c. c. of each water to be tested (as many as four estimations may readily be made at the same time) are placed in beakers of about 100 c. c. capacity, and 50 c. c. of each of the standard nitrate solutions in smaller beakers. Ten c. c. of the test reagent are added to each beaker, and afterwards a small quantity of zinc dust (7–8 mg.). If nitrites are present in the water the pink color will appear without the addition of zinc dust (Griess's test). If nitrates are present a more or less intense pink color will appear on the addition of the zinc dust, and after about 15 minutes the intensity of the color is compared with that of the three standard nitrate solutions, the water being diluted until its color corresponds with that of one of them. The author suggests that perhaps the greatest accuracy may be secured by comparing with the most dilute standard, in which case it may frequently be necessary to dilute the water a hundredfold. The necessary dilution being indicated by this preliminary test, the test is repeated with diluted water, the comparison of color with that of the standard chosen being made after 15 minutes in graduated Nesslerizing tubes of equal caliber, as follows: "The standard solution occupying 60 c. c. in one cylinder, the water tested is run into the other until the depth of the color appears to be equal. A reading is then made of the quantity necessary. Say 45 c. c. were employed; then $45 : 60 :: 0.1 : x$ (=0.133), and supposing the water to have been ten times diluted, it would contain 1.33 parts nitrogen as nitrates and nitrites [per

100,000]." The tabulated results of comparisons of this new method with the Crum mercury method as modified by Frankland and Armstrong on numerous samples of water, show the new method to give results in most cases slightly higher than the mercury method; this error amounted in only one instance to 0.4 part of nitrogen in 100,000, and was usually below 0.2 part.

The advantage claimed for the test are rapidity, simplicity, and ease of execution, and the small quantity of water required for the determination, 20 c. c. being sufficient. The only precaution mentioned is to avoid the addition of large quantities of zinc dust, as they decolorize the solution.

Absorption of atmospheric ammonia by arable soils, T. Schlösing (*Compt. rend.*, 110 (1890), *pp.* 429 *and* 499).—Previous experiments by the author and by other investigators have indicated that arable soils absorb considerable quantities of ammonia from the air, but the conclusions have not been universally accepted. During the years 1886–90, twenty-five experiments were instituted by the author for the further study of the problem.

Specimens of different kinds of soil were placed in shallow, circular, flat-bottomed glass vessels with a superficial area of 2 square dm., and a depth varying with the weight of the soil. As a certain amount of nitrogen would be brought to the soils in atmospheric dust, one vessel was left empty and the nitrogen determined in the dust collected in it. All these vessels were placed inside an apparatus arranged to provide for circulation of air. Two other vessels of the same kind containing dilute sulphuric acid were placed one inside the apparatus and the other in open air. The amounts of ammonia absorbed by the acid in the two vessels were compared to obtain an indication of the amounts of atmospheric ammonia which would come in contact with the soil of the experiments as compared with the amounts which would come in contact with ordinary cultivated soils. In estimating the amount of nitrogen gained by the different soils under experiment, a correction was made for the amount of nitrogen in the atmospheric dust. It was found that the acid in the vessel placed near those containing the soils under experiment inside the apparatus, through which a more or less constant current of air was passing, absorbed more ammonia than had been found to be absorbed by acid exposed to the open air. The inference was that more atmospheric ammonia had been brought in contact with these soils than would be the case with ordinary cultivated soils. A correction for ammonia contact was therefore made in the figures for total gain of nitrogen by the soils. This correction, which varied with the different soils, was much larger than that for atmospheric dust. The figures quoted below for the annual gain of nitrogen per hectare are those obtained after the subtractions for both atmospheric dust and ammonia contact.

Determinations were made of the amount of nitrogen in the forms of ammonia, nitric acid, and total nitrogen in each soil at the beginning, from time to time during, and at the end of the experiment. The amounts of gain or loss in each specimen were thus learned and the corresponding amounts per hectare were calculated. The author urges, however, that the excess of ammonia in the soil at the end over that at the beginning of the experiment does not represent the amount of ammonia absorbed, since part of it is used for the formation of complex nitrogenous compounds, and is not transformed into ammonia and dissolved by the dilute acid used for extracting and determining the amounts of ammonia in the soil. More or less of the ammonia would of course be changed to nitric acid.

The twenty-five experiments were divided into four groups:

(1) The first group included six non-calcareous soils, which had served as material in previous experiments by the author on the fixation of the free nitrogen of the air. Since no gain of nitrogen had been found in either of these soils in the previous experiments, it was assumed that any gain which should be found in the present experiments must be attributed to the absorption of nitrogen compounds from the air. The soils were kept moist during experimental periods of from 495 to 622 days. One was nearly covered, and showed no considerable gain of nitrogen. In the other five the gain ranged from 15.3 to 50.1 kg. per hectare, or from 13.7 pounds to 45.1 pounds per acre per year.

(2) The second group included three experiments, one with a calcareous soil, the other two with a non-calcareous soil and subsoil. The experiment continued 115 days from May 4. The soils were moistened daily. The calcareous soil gained nitrogen at the rate of 47.1 kg. per hectare, or 42.4 pounds per acre, and the non-calcareous soil and subsoil at the rate of 39.1 and 34.4 kg. respectively per hectare, or 35.2 and 31.0 pounds per acre per year.

(3) The third group included eight experiments with four specimens of surface soils and the corresponding subsoils, all calcareous. The experimental periods varied from 163 to 170 days, commencing June 17. In every case there was considerable gain of nitrogen, the gains by the surface soils varying from 40.7 to 46.5 kg. per hectare, or from 36.6 to 41.9 pounds per acre, and by the subsoils from 30.8 to 40.1 kg. per hectare, or from 27.7 to 36.1 pounds per acre per year.

(4) The experiments of the fourth group were made with the same kinds of soil as the third, at the same time, and in the same manner, except that the soil was not moistened, but was thoroughly stirred once a week. It therefore retained only hygroscopic moisture and was quite dry. The gains of nitrogen averaged somewhat larger than in the third group. The most noticeable difference between the results with the two groups was in the quantities of ammonia and nitric acid at the end of the experiments. In the third group the quantities of ammonia changed very little, but that of nitric acid increased and at the end was large. In the fourth group, on the other hand, the quantities of nitric

acid remained nearly constant and the increase of nitrogen was almost wholly in the form of ammonia. In other words, nitrification was active in the moist but not in the dry soils.

Taking the results of all the groups together, there seemed to be rather more gain of nitrogen with calcareous than with non-calcareous soils, but the difference was neither regular nor pronounced. The following are the author's conclusions:

From these investigations it follows that arable soils absorb atmospheric ammonia, whether they are devoid of vegetation, calcareous, acid or neutral, dry or wet. The quantities of nitrogen thus gained are too important to be neglected.

The absorption of ammonia by the soil is dependent upon the difference of tension of the ammonia in air and soil. The absorption, therefore, attains its greatest intensity when the tension in the soil is zero. This condition is realized when the soil is moist and when nitrification causes ammonia to disappear as rapidly as it is absorbed. When the soil is dry nitrification stops, the larger part of the ammonia absorbed retains its form, and increasing in amount effects a tension in the soil. The absorption, therefore, constantly diminishes. Thus moisture in the soil favors the fixation of ammonia, and dryness retards it.

Absorption depends essentially on the renewal of air at the surface of the soil. It is therefore not a matter of indifference whether the surface of a field is free from vegetation or is covered by the residue of crops or by spontaneous vegetation.—[W. O. A.]

Green crops as nitrogenous manures, A. Müntz (*Compt. rend.*, 110 (1890), *p.* 972).—For green manuring leguminous plants are generally selected. Their value for this purpose is due to their power of gathering nitrogen especially from the air. The author considers that their effectiveness when plowed under as green manure will be proportioned to the rapidity with which their nitrogen is changed to nitric acid. To get light upon the subject, he compared the rapidity of nitrification of green lupines with that of dried blood, which is one of the most active nitrogenous fertilizers, and of sulphate of ammonia, which undergoes especially rapid nitrification, in a series of experiments in which each of the substances was added to a light calcareous soil and to a heavy clay soil only slightly calcareous. For each experiment enough of the nitrogenous material was added to furnish one gram of nitrogen for a kg. of soil. The accompanying tabular statement shows the amount of nitric acid formed:

Fertilizing materials supplying 1 gram of nitrogen.	Light calcareous soil.	Heavy clay soil slightly calcareous.
	Milligram.	*Milligram.*
Green lupine	183	86.0
Dried blood	161	3.6
Sulphate of ammonia	288	5.1

It is evident that the heavy soil was unfavorable to nitrification, only 5.1. mg. of nitric acid being formed from the sulphate of ammonia. That so much more was formed from the nitrogen of the lupines is attributed by the author to the loosening of the soil by the decomposing plants, by which aëration was facilitated. In the lighter soil, which was relatively favorable to nitrification, 288 mg. of nitric acid was formed from the sulphate of ammonia. The nitrification of the lupine exceeded that of the dried blood.

Field experiments with maize grown for fodder on land manured with green alfalfa, with dried blood, and with sulphate of ammonia gave results very favorable to the alfalfa.—[W. O. A.]

The decomposition of organic fertilizers in soil, A. Müntz (*Compt. rend.*, 110 (1890), *p.* 1206).—Under ordinary circumstances the nitrogen of all organic substances decaying in soil, changes into nitrates. In 1877 and later Schlösing and Müntz showed that this transformation is due to ferments which they have studied. Of the numerous organisms of soil, the nitro bacteria are the most important, since it is they that change the nitrogen into nitric acid, the form most assimilable by plants.

In a recent series of experiments, Müntz shows that there are still other organisms which in their work precede those of nitrification. That is to say, these latter transform organic nitrogen into ammonia from which the nitric acid is produced. They are probably indispensable to the life of the nitrifying organisms and to the complete transformation of nitrogenous organic matter. Experiments to decide the question as to whether the nitro-bacteria can live upon other nitrogen compounds besides ammonia, may not prove very difficult, since Winogradsky has succeeded in isolating them in pure cultures. Meanwhile, however, Müntz shows in the present investigation that the agent for the production of ammonia exists in all soils, and that it works the transformation of the nitrogen of organic materials, especially manures, into compounds of ammonia.

There is great difference as to the facility with which the nitrogen of humic compounds and that of other organic substances, such as stable manure and other excreta, dried blood and flesh, horn, wool, leather, oil cakes, etc., is nitrified. Thus the nitrogen of humus is assimilated by plants very slowly, but that of the other substances mentioned, more or less rapidly.

In order to get an insight into the nature of the transformation products of organic nitrogen into ammonia or nitric acid, Müntz experimented with several soils. Some of them were acid and not adapted to nitrification, while others were more or less favorable to the action of nitrifying ferments. Each kind of soil served in three experiments. In one it was used by itself; in a second horn, and in a third dried blood was added. The experiments continued from 11 days to 8 months. In one case the soils were sterilized at 90° C., at which temperature the nitrifying ferment is killed but most of the others are

left intact. When sterilized at 120° C., it was found that generally no ammonia was formed, thus implying that the ammonifying ferment is destroyed. But when soils thus sterilized were inoculated with a particle of fresh soil, the production of ammonia recommenced.

The principal results of the experiment may be recapitulated by saying that in soils in which nitrification could not occur or in which the nitric ferment had been killed, the nitrogen of organic substances was changed to ammonia exclusively. Soils poorly adapted to nitrification had nearly all their nitrogen changed into ammonia and but little to nitric acid; and in arable soils where nitrification was very intense ammonia was not entirely absent.

The author concludes that in all soils special organisms exist which exercise the function of converting the nitrogen of organic matter into ammonia. But there are almost always coexisting organisms which transform the ammonia thus produced into nitric acid. Although the work of the former is only preparatory, yet it is useful and perhaps even indispensable.

In another article (*Compt. rend.*, 111 (1890), *p.* 75) P. Péchard calls attention to his own results which are identical with those of Müntz above referred to, but were published earlier in the account of an investigation on the influence of gypsum and of clay on the retention, nitrification, and fixation of nitrogen (*Compt. rend.*, 109 (1889), *p.* 646). He there showed that in the decomposition of organic matter the formation of ammonia precedes that of nitric acid. This conclusion, he says, was to be expected after the work of Shützenberger on the decomposition of albuminoid substances by the earthy alkalis, especially when Duclaux had shown that their decomposition in the manner named is similar to that produced by the action of microbes.—[W. O. A.]

The decomposition of rocks and the formation of arable soil, A. Müntz (*Compt. rend.*, 110 (1890), *p.* 1370).—In this article the author broaches the very striking theory that either nitro-bacteria or similar microscopic organisms constitute one of the principal agencies in the decomposition of rock and formation of soil, and supports it by a variety of observations. Both igneous and sedimentary rocks undergo constant disintegration. The fine particles either left *in situ* or transported by wind and water during geologic epochs, make the basis of arable soil. The disintegration is caused in part by atmospheric agencies, chemical and physical, and in part by the action of living organisms. It is well known that plants of the higher and lower orders growing on the surfaces or in the fissures of rocks, tend to disintegrate them by the action of acid or other secretions, as well as by mechanical means. According to the observations of the author, microscopic organisms exert a similar but more subtle and far more general action. He has studied the action of these nitrifying ferments upon high mountains, above the limits of ordinary vegetation, as well as in lower regions. As first indicated by the researches of Schlösing and Müntz and explained later by the

investigation of Winogradsky, these ferments are able to assimilate ammonium carbonate, form organic matter from it, and at the same time change part of the nitrogen of the ammonia into nitric acid. The author also believes that they may utilize for their sustenance the very minute traces of alcohol which he has found to be widely distributed and a constant constituent of the atmosphere. All the conditions for their growth would therefore be fulfilled on bare rock and on the highest mountain peaks. Being of microscopic size they are able to penetrate the capillary interstices of rock and the nitric acid which they produce, acting constantly through long periods of time, becomes an effective means of disintegration.

The disintegrated particles are found on examination to be uniformly covered by layers of organic matter, evidently formed by these organisms. This accords with the observation of Winogradsky, that the nitro-bacteria grown in liquids free from organic matter gather about deposits of carbonates and transform ammonia and carbonic acid into organic matter, which thus accumlates in considerables quantities.* The accumulation of the organic matter of the soil thus begun is increased later by the residues of the vegetation of higher orders. By putting specimens of disintegrating rock into sterilized tubes and making bacteria cultures with them, the author showed the presence of nitrifying organisms in the bare rocks of the Alps, Pyrenees, Auvergne, and Vosges. Rocks of the most widely varying mineralogical character —granite, porphyry, gneiss, mica schist, volcanic rock, limestone, and sandstone—were thus shown to be covered with nitro bacteria. Schlösing and Müntz have shown that these organisms become dormant at low temperature, so that their activity is limited to the summer, especially at high altitudes, but their life does not cease in winter, for he has found them "living and ready to resume their activity after a sleep of ages under the enduring ice of glaciers, where the temperature does not rise above zero."

But while the organisms are so abundant on the bare rocks of high mountains where the conditions for their action are most simple, their nitrifying activity is exercised on a far vaster scale under the normal conditions existing at lower levels, where the rock is covered with vegetable soil. They act upon minute fragments, and thus reduce them to smaller and smaller size; nor are they limited to the surface, but they penetrate into the interior of the rock mass. This is the case with the rock material known as "rotten rock," the particles of which become separated, as often happens in limestone, schists, and granite. "In such decomposing rocks," says the author; "I have always established the presence of the nitrifying organism." One of the most striking examples of this is furnished by the mountain in Switzerland called in German Faulhorn, in French Pic Pourri ("Rotten Peak"), which consists of a

* See Experiment Station Record, vol. II, p. 754.

calcareous schist, friable, and in process of disintegration. Its whole mass is invaded by the nitric ferment.

"When we consider the feeble intensity of these phenomena we are tempted to underestimate their importance, but being so general and continuous they really deserve to be classed among the geologic causes to which the crust of the earth owes its actual physiognomy, and which especially have contributed to the deposits of fine material which constitute arable soil."

In the view thus presented by Müntz, nitro bacteria, the existence of which was first indicated by Schlösing and himself in 1877, and which were first isolated and definitely studied by Winogradsky a little over a year ago, are of the highest interest to the geologist as one of the dynamic agencies which decide the topography of the earth's surface; and to the farmer as the means by which the nitrogen compounds of the soil are changed into the nitrates upon which his crops feed, and even the soil itself is formed.—[W. O. A.]

Microbes and root tubercles in relation to the fixation of free nitrogen by peas, Schlösing, jr., and Laurent (*Compt. rend.*, 111 (1890), *p.* 750).—Experiments by the authors are reported, which confirm the fixation of free nitrogen by peas and the connection of microbes and root tubercles with the process. While previous experiments had been made by what they designate the "indirect method" of comparing the nitrogen in the seed and soil at the beginning of the experiment with the amount found in the plant and soil at the end of the experiment, and taking the difference as the measure of the quantity of nitrogen acquired from the air, these experimenters employed the "direct method," growing plants in sand inside an apparatus containing a definite volume of air, the nitrogen in which was estimated at the beginning and at the end of the experiment, and taking the loss as the measure of the amount fixed by the plant. The apparatus was also utilized in experiments where the nitrogen gained was estimated by the "indirect method," explained above. In two experiments the apparatus and sand were sterilized, peas planted, and their inoculation provided for by the addition of crushed root tubercles. The peas grew during 3 months. The plants were small, apparently healthy, and produced flowers, but no fruit. At the end of the experiment the roots had abundant tubercles. By the direct method it was estimated that the plants in the first experiment acquired 36.5 and those in the second experiment 32.5 mg. of nitrogen. By the indirect method the quantities of nitrogen fixed were estimated at 40.6 and 34.1 mg. respectively. The difference in results by the two methods is attributed to unavoidable errors in analysis. Still another experiment was made, but without determination of gaseous nitrogen and without inoculation. The plants had no root tubercles and showed by the indirect method no considerable gain of nitrogen. The inference is that the peas which were inoculated by the bacteria and had root tubercles, fixed gaseous nitrogen.—[W. O. A.]

Contributions to the knowledge of the nitrogenous compounds of arable soil, Berthelot and André (*Compt. rend.*, 112 (1891), *p.* 189).—In previous investigations* the authors have studied the formation of ammonia in ordinary cultivated soil free from considerable quantities of vegetable mold. Such soils contain extremely little ready-formed ammonia or ammonium salts, their nitrogen being largely in the form of amide-like compounds which yield ammonia gradually by treatment with acids or dilute alkalis, cold or hot, and even by treatment with water at ordinary temperature. These amides are the source of the ammonia ordinarily found in the analysis of soil. The same gradual decomposition by water and by alkaline and earthy carbonates gives rise to the ammonia which is emitted by cultivated soils and diffused through the atmosphere. The amide substances which are thus decomposed may be divided into three classes: (1) Amides proper, which are formed by the union of acids with ammonia and from which ammonia is more or less readily evolved by the action of acids and alkalis; (2) alkalamides which are formed by the union of volatile nitrogenous bases with acids, comport themselves similarly to the amides, and yield volatile nitrogenous compounds; (3) alkalamides which are formed by the union of non-volatile nitrogenous bases or allied bodies with acids, and in being decomposed yield non-volatile nitrogenous products. Of these alkalamides, some are soluble in water, others are insoluble. The soluble ones when broken up by acids or alkalis may yield products, acid or alkaline, which are soluble, or those which are insoluble in water. Similar distinctions apply to the nitrogenous organic compounds of ordinary cultivated soil. A knowledge of them is indispensable for the interpretation of the analysis of the soil and the understanding of its constitution; nor can it be doubted that they are important factors in the absorption of nitrogenous and carbonaceous compounds of the soil by the plant, and in vegetable nutrition generally.

In the study of a clay soil, it was found that the ratio of the organic carbon to the nitrogen was such as would correspond to one part of albuminoid material with three parts of humic or allied compounds, such as are derived from carbohydrates. It is to be expected that the researches of Schützenberger on the constitution of proteids may throw light upon that of the nitrogenous compounds of the soil.

The authors have studied the changes produced in the nitrogenous compounds of soil by the action of acids and alkalis of different degrees of concentration, at different temperatures, and during different intervals of time. They determined in each case the amounts of nitrogen (1) disengaged as ammonia or other volatile alkaline compounds; (2) remaining in non-volatile compounds soluble in water; and (3) remaining in insoluble compounds. In a number of cases they also determined the amount of carbon in each of these compounds. With a cold

* Ann. Chim. et Phys., 6 ser., 11 (1887), p. 289.

concentrated solution of potash, nitrogen was eliminated in the form of ammonia or other volatile alkaline compounds, at first very rapidly, then slowly, and afterwards very slowly and in amounts proportioned to the time of the action. It was concluded that there were in the soil two distinct amide-like compounds, differing in the facility with which they are transformed into ammonia. Besides the nitrogenous material transformed into ammonia, a much larger portion was rendered soluble in water, but a part of this latter gradually reverted to an insoluble form. The residue of the soil after extraction by potash, on treatment with dilute acid, yielded still more ammonia and amide-like compounds. Over nine tenths was thus rendered soluble by either acid or alkali or both. The tendency of the action of both acid and alkali was to decompose the nitrogenous compounds and to form products of lower molecular weight.

In conclusion, the authors add that these experiments show how the insoluble nitrogen of humus compounds is gradually rendered soluble and assimilable. While the action of the plant upon these compounds in the soil is certainly not identical with that of the acids and alkalis of the laboratory experiments, nevertheless the latter offer certain grounds of comparison in the consideration of the chemical processes induced by earthy carbonates and by carbonic acids, as well as by the acids formed by the plants. The length of duration of these natural processes makes up for the slowness as compared with the more energetic action of the mineral acids and alkalis. That is to say, the comparatively weak bases and acids which occur in the soil and are elaborated by plants, tend to set free the nitrogen of humus, both that of the vegetable matter of which it is formed and that of the ammonia which it absorbs from the air. It may be assumed that alkaline and acid fertilizers, such as lime, ashes, and acid phosphates, serve a similar purpose in rendering the nitrogen of the soil available to plants.—[W. O. A.]

The volatile nitrogenous compounds exhaled by arable soil, Berthelot (*Compt. rend.*, 112 (1891), *p.* 195).—In continuation of previous investigations the author made experiments with argillaceous sands, or clays poor in nitrogen. These were placed in porcelain pots, under bell glasses of 50 litres capacity. Arrangements were provided for introducing water to moisten the soils and collecting the water which condensed on the bell glass. A dish containing dilute sulphuric acid was also placed under the bell glass to absorb the ammonia emitted from the soil. The experiments continued from May to October, 5½ months. During the first half of this time the soil was moistened occasionally. The moisture which collected on the bell glass was removed weekly and sulphuric acid was added to it to hold the ammonia. During the remainder of the time of the experiment the soil was not moistened; it became dry and the moisture ceased to condense on the

bell glass. At the end of the experiment determinations were made of (1) the ammonia absorbed by the dilute sulphuric acid; (2) the ammonia taken up by the water of condensation and expelled by distilling with magnesia; (3) the organic nitrogen remaining after treatment with magnesia. Other experiments were made in the same way, except that sundry non-nitrogenous organic matters, such as mannite, starch, and humus derived from sugar, were added to the soil, but without essential difference in result. While the soils were kept moist, a not inconsiderable amount of ammonia and a still larger quantity of organic nitrogen compounds were given off. The total nitrogen volatilized in these forms and collected in the acid and water was 2 mg. from 1 kg. of soil in 2½ months. During the time that the soil was not moistened, only minute quantities were exhaled. In these cases also the proportion of organic nitrogen was several times larger than that in the form of ammonia.

The most interesting result was that the nitrogen given off under these conditions by argillaceous sand in the form of volatile organic compounds, was invariably larger in amount than that given off as ammonia. In the previous experiments referred to, cultivated soil twenty times richer in nitrogen than the argillaceous sand of these experiments like wise gave off two kinds of compounds, but the ammoniacal nitrogen exceeded the organic in amount. This was the case both with soil destitute of vegetation and with plants of a higher order. The author infers that these phenomena are always brought about by the influence of microbes or of plants of a low order, which are contained in all soils and which manufacture the small quantities of volatile organic nitrogenous compounds observed. These latter he speaks of as a kind of vegetable ptomaines.—[W. O. A.]

Researches on humus substances, Berthelot and André (*Compt. rend.*, 112 (1891), *p.* 916).—Our cultivated soils are formed by the union of various minerals with brown organic compounds. The latter, classified as humus, play an important rôle in the fertility of soil and in the nutrition of the plant, but their function has been established by practical observers rather than defined and analyzed by scientific research, and still remains one of the great unsolved problems of agriculture.

Not only do these compounds or the products of their transformation play an essential rôle in the nutrition of plants and especially in the circulation of nitrogenous products, but they also contribute to the power of the soil to hold in reserve certain mineral compounds despite the dissolving action of water, a faculty which is also possessed by basic silicates and is inaptly designated as absorptive power. Great as is the agricultural interest attaching to these humus compounds, chemists appear to have been repelled from their study by their instability, their insolubility, and their non-crystalline nature. It is hardly possible in the present state of our knowledge to represent them by

the constitutional formulas usual in organic chemistry. Nevertheless they present problems of great interest from the standpoint of chemistry and vegetable physiology because of the phenomena of hydration and dehydration, molecular condensation, and of transformation of colloidal substances which they manifest.

After devoting some time to the study of nitrogenous humus compounds which occur in the soil and are complex and of uncertain origin, it seemed advisable to the authors to devote their attention to those formed artificially in accordance with well-defined principles, and containing only carbon, hydrogen, and oxygen. For this purpose they used the product of the action of hydrochloric acid on cane sugar, which is known as ulmin and ulmic acid, and which in their view should be regarded as a condensed anhydride or a mixture of several anhydrides derived from certain acids which result from the metamorphosis of sugar. Treated with alkaline solutions, this anhydride swells up in the manner of colloid substances and forms salts of different degrees of basicity, some of which are soluble and some insoluble. The insoluble basic potassium salts are of special interest. These have escaped the attention of previous observers, having been mistaken for other substances. Such is their insolubility that the anhydrate formed from sugar, just referred to, is able to remove nearly the whole of the potash or soda from a solution in water by forming the insoluble basic salts. It is also able to decompose small quantities of potassium chloride setting hydrochloric acid free. Its behavior with sodium, barium, calcium, and also with ammonium is similar to that with potassium. The authors devoted their special attention to the insoluble potassium salt, because of its especial interest in explaining the absorptive powers of humic compounds. The salt resists the solvent action of water to a very marked degree. Even when boiled with 120 times its weight of water for an hour it was but slightly decomposed, and was but little acted upon by carbonic acid in the cold. From a solution of potash in 120 times its weight of water, the anhydride takes the amount required to form the insoluble salt just described, and by this means nearly all the potash can be removed from even a very dilute solution. Other salts of potassium, sodium, barium and ammonium were studied. Ammonia forms with the anhydride amido acid salts.

These researches throw a new light on the function of humus compounds in the soil, by indicating that they combine with both ammonia and the mineral alkalis, protect them from the leaching action of the water which circulates through the soil, and hold them in reserve for the use of the plants. In other words, the absorptive power of the soil which has been currently attributed to hydrous silicates, is shared also by the humus compounds.—[W. O. A.]

Gain or loss of nitrogen by soils, A. Pagnoul (*Ann. Agron.*, XVI (1890), 6, *p.* 250).—To test the gain or loss of nitrogen in a soil with and without crops growing upon it, trials were made with soil in glazed

earthenware pots provided with arrangements for aëration and the collection of drainage water. In each pot were placed 22 kg. of soil containing 22.44 grams of nitrogen, to which were added dried blood containing 0.54 gram of nitrogen, and sulphate of ammonia containing 1 gram of nitrogen, making altogether 23.98 grams of nitrogen. Calcium sulphate and natural phosphate were also added. The pots were divided into three lots of two each, designated A, *a*; B, *b*; C, *c*. The experiment continued two years, from March, 1888, to March, 1890. Grass was sown and harvested each season in B and *b* and red clover in C and *c*. In pots A and *a* no plants were allowed to grow. Determinations were made of nitrogen as ammonia and nitric acid in the drainage waters of each season; and of the nitrogen in the soil and fertilizers at the beginning of the experiment in the crop of each season, and in the soil at the end of the experiment. The results so far as the gain of nitrogen by the soils is concerned, are recapitulated in the table herewith, in which averages of duplicate trials are given. The nitrogen gained of course came from the air.

Nitrogen statistics.

Nitrogen—	Without plants, average of A and *a*.	With grass, average of B and *b*.	With clover, average of C and *c*.
	Grams.	*Grams.*	*Grams.*
Remaining in soil at end of experiment*	24.20	26.95	30.80
Removed by crops of two seasons	....	1.47	4.20
Removed in drainage water of two seasons	0.87	0.08	0.20
Total	25.07	28.50	35.20
Amount in soil at beginning of experiment	23.98	23.98	23.98
Gross gain by soil and crops	1.09	4.52	11.22
Loss in drainage	0.87	0.08	0.20
Net gain by soil and crops	0.22	4.44	11.02
Removed in crops	....	1.47	4.20
Net gain by soil	0.22	2.97	6.82

* Including nitrogen of roots of plants.

The surface area of the soil in each pot was 7.54 square dm. Estimated per hectare, the net gain of nitrogen by the soil after the removal of the crops would be, without plants 29 kg., with grass 394 kg., and with clover 904 kg.; or per acre without plants 26.1 pounds, with grass 354.6 pounds, and with clover 813.6 pounds.

As results of this investigation it appears that, (1) the loss of ammonia by drainage was inconsiderable in the soil either with or without plants; (2) the loss of nitric acid was quite large, especially in the soil without vegetation (taking the loss of nitric acid in the experiment with grass as 1, with clover it was 3, and without plants 17); (3) in the second year the soil without plants lost less nitric acid, and the soils with crops more than in the first year; (4) the crops of the second year were smaller than those of the first year, notwithstanding the greater apparent nitrification and the gain in nitrogen.—[W. O. A.]

Citric acid as a normal constituent of cows' milk, T. Henkel (*Landw. Vers. Stat.*, 39. *pp.* 143–151).—The author prefaces the report of his investigations with a brief summary of the substances besides albuminoid materials, fat, milk sugar, and ash, which, according to present views, occur in small quantities in normal milk. Of nitrogenous bodies other than the albuminoids, he mentions urea, ammonia, hypoxanthin, and lecithin. The old theory that peptones are contained in milk, is believed to have been disproved by more recent investigations.* Among the nitrogen-free materials of the milk he recognizes cholesterin.

Regarding the organic acids of milk, Soxhlet† first remarked that the amount of lime contained in solution in milk seemed to be opposed to the fact that milk contains phosphoric acid in solution. He suggested the presence of an "organic phosphoric acid" whose neutral calcium salt was soluble. Söldner ‡ in his work on the salts of the milk, further advocated the presence of organic acids in milk. According to Heidlen,§ lactic acid is not a constituent of fresh milk, and only occurs in milk which has stood. The author states that the only previous mention of the actual finding of an organic acid in fresh milk is by Duval,|| who stated that he found the salt of such an acid in mares' milk. This salt, as described, crystallized in groups of small needles, was not volatile, gave a peculiar odor on heating, and differed from hippuric acid in its relation to silver nitrate and iron chloride. He named this acid *acide equinique.*

The present investigations were made by the author under the supervision of Professor Soxhlet, at the Central Experiment Station in Munich. It seemed probable from all previous investigations that the organic acids if present must be contained in the milk serum in the form of soluble salts. A serum was prepared from separator skim milk by removing the casein, first with a strong rennet solution and then with acetic acid and Spanish clarifying earth (*Klärerde*). and neutralizing with milk of lime to the point of acidity of normal milk serum (100 c. c. = 3. 2 c. c. fourth-normal soda solution). By this means a clear milk serum of normal acidity was obtained. On evaporation of the serum a precipitate separated out, which was found by qualitative tests to be the calcium salt of an organic acid, containing also a small admixture of calcium phosphate. This organic acid was obtained free (1) by decomposing the calcium salt with oxalic acid, and (2) by preparing the lead salt and decomposing it with hydrogen sulphide. When purified and concentrated both these solutions gave a crystalline mass. Larger quantities of the pure acid were prepared by decomposing the calcium salt with H_2SO_4, dehydrating with anhydrous gypsum, placing over

* Jahresber. f. Thier Chem., 6.13; Zeitsch. f. physiol. Chem., 2, 28; *ibid* 9, 591.
† Jour. f. prak. Chem., 6, 1.
‡ Landw. Vers. Stat, 35, 354.
§ Ann. d. Chem. u. Physik., 45, 263.
|| Compt. rend., 82, 419.

H_2SO_4, and finally extracting with ether. One hundred grams of water-free crystals of the acid were obtained in this manner. This acid agreed with pure citric acid in (1) elementary composition; (2) the ability to form a saturated sodium salt giving no acid reaction with phenolphthalein; (3) water of crystallization of the calcium salt and the behavior of this when the salt was dried over H_2SO_4, or at 100° C.; (4) the calcium content of the saturated (tri) and unsaturated (di) calcic salt; (5) melting point; (6) solubility in ordinary solvents; and (7) giving the Sabanin-Laskowski reaction, which is peculiar to citric and aconitic acids only.

Experiments were next made to determine whether the citric acid was actually contained in the milk, or whether it was possibly formed during the process of preparation from a decomposition of the constituents of the milk, either by the rennet or by the continued evaporation of the serum. Serum prepared from fresh cows' milk without the use of rennet, (1) by means of HCl, etc., and (2) by filtering the milk through cells of unglazed earthenware and heating, yielded in both cases an organic acid with the characteristics given above. Samples of serum prepared in each of the three ways (with and without rennet) were rapidly evaporated in a vacuum at 40° C.; all yielded the same amount of calcium citrate found in previous trials. These results showed conclusively that the citric acid found was not a product of the decomposition of the milk constituents by the rennet or by the continued heating of the serum It must therefore be a constituent of the milk used in the investigations.

Finally, 30 samples of milk from different herds of cows receiving different rations, and the mixed milk from creameries, were examined with reference to their citric-acid content. The amount of calcium salt found (containing only a trace of calcic phosphate) varied from 1.5 to 2.1 grams, equivalent to from 1 to 1.4 grams of citric acid per liter of milk. Numerous examinations made of the concretions and sediment forming in sterilized and unsterilized condensed milk, showed these materials to consist to considerable extent of calcium citrate.

The results of these investigations lead the author to conclude that citric acid is regularly present and a normal ingredient of cows' milk.

Concerning the origin of citric acid in milk, A. Scheibe (*Landw. Vers. Stat.*, 39, *pp.* 153–170).—This investigation, like the preceding, was made in the laboratory of the Central Experiment Station at Munich, under the supervision of Professor Soxhlet. The questions proposed by the author were: (1) Is citric acid contained in other than cows' milk? and (2) From what source does the citric acid in milk come? In a preliminary report on the investigations of Henkel, Professor Soxhlet stated that no citric acid had been found in human milk, and he suggested that its presence in the milk of herbivora might perhaps be accounted for in two ways: (1) Citric acid being a constituent of vegetable foods, as hay, roots, etc., may pass from the food into the milk;

(2) being a product of the decomposition of cellulose, it may possibly be formed, together with other organic acids and gases, in the process of fermentation of the cellulose in the alimentary canal. According to either proposition the presence of citric acid would be traceable directly or indirectly to the food. Although the weight of evidence seems to be to the effect that citric acid when taken into the organism is rapidly burned to carbonic acid and water, it is suggested that a transfer of citric acid from the food to the milk is still conceivable, since in the secretion of milk not the final products of decomposition but probably the substance of the body itself is drawn upon. Carbohydrates are also completely burned within the body, but milk-producing animals separate a carbohydrate (milk sugar) in large quantities in the milk.

The author proceeded to make exact determinations of the amount of citric acid in milk, according to a quantitative method devised by himself, which is described in detail. This method depends upon setting free the citric acid in the prepared milk serum with 2½ normal sulphuric acid, dissolving the freed acid in alcoholic ether, separating the milk sugar by crystallization, and finally precipitating the citric acid (together with the sulphuric and phosphoric acids) with alcoholic ammonia. The citric acid is determined in the final precipitate by decomposing the ammonium citrate with a solution of bichromate of potash, and measuring the carbonic acid evolved. The amount of citric acid found in cows' milk by this method was 1.7 to 2 grams per liter—a somewhat larger amount than Henkel found.

With this exact method the author separated citric acid from human milk also, the amount found being 0.54 grams per liter of milk, or less than a third of that in cows' milk.

After the presence of citric acid in goats' milk had been recognized, feeding experiments were undertaken with goats to study the influence of different rations on the citric acid content of the milk. In different periods rations were fed consisting respectively of (1) ordinary hay, (2) brewers' grains, (3) beets and hay, (4) beets, oat straw, and linseed cake, (5) clover hay, (6) black bread, (7) black bread, white bread, and wheat flour alternately, (8) hay and increasing amounts of citric acid partially neutralized with sodium hydrate, and (9) pea soup. The latter ration, however, was only digested to a slight extent and was not eaten readily, so that this period was partially a hunger period. The results of these feeding experiments lead the author to conclude that—

(1) The citric-acid content of goats' milk is practically the same as that of cows' milk, amounting with ordinary feeding to from 1 to 1.5 grams per liter. The variations from day to day on the same food were not inconsiderable, and the percentage of citric acid in the solids varied even more widely.

(2) The citric acid in milk is not derived from citric or other organic acids contained in the fodder (hay, roots, etc.), for (*a*) it is contained in human milk, although in smaller amount; (*b*) the feeding of increasing

quantities of citric acid, amounting in some cases to forty times the amount given off in the milk, was accompanied by no increase of citric acid in the milk produced; (*c*) during the feeding of bread, wheat flour, and pea meal, "which surely contained no citric acid," the milk continued to show the normal amount of this acid; and (*d*) when the animals were fasting or when only a very limited quantity of food was eaten, there was no decrease noticed in the citric-acid content.

(3) Citric acid does not come from the products of the fermentation of cellulose in the alimentary canal of herbivora, for human milk contains citric acid, and when bread, wheat flour, or pea meal were fed, and during fasting, the critic-acid content remained normal.

The presence of citric acid in the milk given by fasting goats, is analogous to the presence of milk sugar in the milk of carnivora receiving food free from carbohydrates, and of fasting herbivora. When the origin of milk sugar shall have been clearly shown, it may be possible to secure some light as to the formation of citric acid from the other constituents of the food or from the animal substance itself.

Although these investigations furnish no definite answer to the question as to the origin of the citric acid of milk, the author believes they indicate that citric acid is a specific milk constituent, which, like the casein, the glycerides of the volatile fatty acids in the butter fat, and the milk sugar, is a product of the lacteal glands; but from what constituents of the food or the body these ingredients, especially milk sugar, are formed, it is at present impossible to say with certainty.

Volatile fatty acids in Holland butter, A. J. Swaving (*Landw. Vers. Stat.*, 39, *pp.* 127–141).—The author first briefly notices some of the previous investigations made with a view to determining the influence of food, period of lactation, etc., on the volatile fatty acids of butter.

Thus, he states that in 1882 Munier* examined samples of butter from the vicinity of Amsterdam, during the whole year, and found that the percentage of volatile fatty acids was lowest during the months of October, November, December, and January.

In 1888 Coster, Van Hoorn and Mazure† examined butter made by themselves each month of the year from the milk of a large number of cows. They conclude from these studies that in the critical examination of butters the season of the year in which they were made should be considered.

The investigations of Cornwall and Wallace,‡ in which examinations were made of the butter produced by individual cows during a year, showed no constant relation between the volatile fatty acids and the season, breed, age of animal, feeding, or time since calving. They give as the average of 80 samples of butter, 13.68 c. c. of tenth-normal alkali for 2.5 grams of melted butter fat.

* Zeitsch. f. analyt. Chem., 82, p. 397.

† S. verslag van den toestand der gemeente Amsterdam gedurende het jaar 1888.

‡ Zeitsch. f. analyt. Chem., 1887, p. 317.

Besana* examined 114 samples of butter from December, 1887, to April, 1888, which came from 30 different Italian provinces and represented 96 different dairies. The results ranged from 21.8 to 30.19 c. c. tenth-normal alkali for 5 grams butter fat (Reichert-Meissl-Wollny method).

Nilson† made experiments extending over one year with 15 cows all of the same breed, which were fed rye, beets, and hay. The volatile acids ranged from 9.27 to 20.5 c. c. tenth-normal alkali per 2.5 grams of butter fat (Reichert figures). Nilson claims that the content of easily melted glycerides and the qualities of the butter fat accompanying this are not dependent on the feeding, but that the differences between summer and winter butter are due rather to the fact that at the time when cows are feeding on pasturage and green fodders they are more likely to be in the first stages of the milking period.

In opposition to this belief are the investigations of Adolf Mayer,‡ which indicated that not only the lactation period, but also beyond doubt the food had a marked influence on the volatile acids of the butter. Spallanzani § came to the same conclusion from his studies of butters from different sections of Italy.

The author's original plan was to have samples of butter sent him every 2 weeks from reliable sources in each province of Holland, accompanied by statements regarding the number, age, time since calving, and breed of the cows from which the butter was made, and the food they received. He hoped in this manner to secure data which would enable him, with due reference to period of lactation and food, to fix limits to the volatile fatty acids which would be of service in the critical examination of the butter.

Although the original plan was not carried out in all its details, the investigations were quite extensive and are a valuable contribution to the knowledge regarding Holland butter.

The author's conclusions are as follows: (1) The formation of volatile fatty acids in the butter is dependent upon both the period of lactation and the food. (2) With the beginning of a new period of lactation the content of volatile acids increases, and as the period advances these acids diminish in quantity. With the beginning of the pasturage season these acids increase, or at least are quite high; as the season advances they decrease in amount. (3) On account of the prevailing differences in the time at which the new period of lactation begins, and of the influence of food on the amount of volatile fatty acids, it becomes impossible to fix the limits of these acids either for the different districts or for the different months of the year. (4) For the

* Sui methodi atti a distinguere il burro artificiale dal burro naturale et le loco mis cele. 1888.

† Zeitsch. f. analyt. Chem., 1889, p. 179.

‡ Landw. Vers. Stat., 34 (1888), p. 261.

§ Contributo allo studio degli acidi grassi volatili di Burro.

critical examination of butter the minimum limit of volatile fatty acids may be taken as that content requiring 19 c. c. of tenth-normal alkali per 5 grams of butter fat, according to the Reichert-Meissl-Wollny method.

Ontario Agricultural College and Experimental Farm, Sixteenth Annual Report, 1890 (pp. 262).—This report includes statistics relating to the college and experimental farm, reprints of bulletins, accounts of experimental inquiries not published elsewhere, and a report of the eleventh annual meeting of the Ontario Agricultural and Experimental Union. The following statements are taken from those portions of the report which relate to the experimental work of the institution:

Bulletin No. 52.—Black knot on plums, J. H. Panton (pp. 39, 40).—A popular account of the life history of the fungus causing black knot on plums (*Plowrightia morbosa*), with suggestions as to remedies.

Bulletin No. 56.—Smut of grain, J. H. Panton (pp. 40–45).—Brief accounts of stinking smut (*Tilletia foetens*), loose smut (*Ustilago segetum*) and corn smut (*Ustilago zeæ mays*), with suggestions as to remedies.

Meteorological observations, J. H. Panton.—A tabulated monthly summary of observations at the college during 1890.

Corn for fodder and silage, C. C. James (pp. 47–62).—Tabulated analyses of the ears, stalks, and leaves of a number of varieties of dent, flint, sweet, and silage corn, with extracts from the reports of investigations on corn issued by stations in the United States.

Analyses of fish, C. C. James (pp. 63–66).—A tabulated record of analyses of the head and entrails of salmon, finely divided refuse from a canning factory, and whole herrings, with comments on the value of such materials as fertilizers.

Sugar beets, C. C. James and W. Skaife (pp. 66–75).—A tabulated record of analyses of sugar beets grown at the college and elsewhere in Ontario in 1890. The following is a general summary for the province:

	Number of samples	Average weight.	Solids.	Sugar.	Purity.
		Lbs. oz.	*Per cent.*	*Per cent.*	*Per cent.*
78 beets, over 2 pounds each in weight	35	2 14	16.15	12.35	75.1
341 beets, under 2 pounds each in weight	82	0 14	17.41	14.10	81.02
Average of 419 beets	117	1 4	17.12	13.68	79 32

The 1889 samples analyzed at the chemical laboratory, Guelph (26 in number), showed an average weight of 2 pounds 2 ounces, solids 18.95 per cent, sugar in juice 14.35 per cent, and purity 75.7 per cent, from which it will be seen that the beets of 1890 were smaller, slightly lower in sugar, but higher in purity, and represent a class of beets much more profitable for sugar making than those of 1889. The difference in value between large and small beets is clearly brought out in the above general summary, the smaller beets being the richer and of higher purity.

A brief account of the cultivation of the crop of sugar beets on the experimental farm is given in another part of the report (pp. 96–98).

Observations with the rain gauge, lysimeters, and soil and air thermometers, C. A. Zavitz (pp. 76, 77).—Tabulated summaries for the months from May to September, inclusive.

Field experiments, T. Shaw and C. A. Zavitz (pp. 100–114, 154–186, and 244–253).—These included tests of varieties and different dates of seeding of barley, spring and winter wheat, and oats; tests of varieties of peas, potatoes, turnips, mangel wurzels, and carrots; experiments in the cultivation and manuring of rape; tests of grasses for pastures, singly and in mixtures; and coöperative experiments with fertilizers on oats, and in the cultivation of corn.

Barley, spring wheat, oats, and peas.—A summary of the experiments with these kinds of grain is reprinted from Bulletin No. 58 of the Ontario Station (see Experiment Station Record, vol. II, p. 675). The detailed tabulated record includes data for 54 varieties of barley, 54 of spring wheat, 92 of oats, and 20 of peas. In the experiments in sowing grain at three different dates (May 1, 9, and 17), the best results were obtained from the earliest sowing.

Winter wheat.—Tabulated data are given for 18 varieties from Ontario seed and 19 from seed from Germany, Russia, England, and France A summary is reprinted from Bulletin No. 53 of the Ontario Station. Of the Canadian varieties, Red Velvet Chaff, Lancaster, Martin Amber, and Volunteer gave the best results; of the foreign varieties, Galezien Summer, White Square Head, Russian Odessa, and Lamed Hybrid.

Potatoes, turnips, mangel-wurzels, and carrots.—Tabulated data are given for 28 varieties of potatoes, 48 of turnips, 29 of mangel-wurzels and 11 of carrots.

Experiments with rape.—Experiments are reported with rape grown on plats of loam, marl, clay, and muck soils, to which salt had been applied at the rate of 400 pounds per acre, on barley in 1888, and on oats in 1889, as compared with rape grown on similar plats to which no salt had been applied. In every case the yield was larger on the plats fertilized with salt. The largest yield was on loam soil and the smallest on the clay. In another experiment, in which nitrate of soda, dried blood and scrap, salt, superphosphate, and unleached wood ashes were used singly and compared with no manure, nitrate of soda produced the largest increase in yield. Level culture gave better results than drilling in both 1889 and 1890. In an experiment in which 4 pounds of seed per acre were sown in drills and the plants on some of the plats were thinned to 15 inches apart, the thinning very materially reduced the yield.

Pasture grasses.—The results of an 8 years' test of 15 species of grasses grown singly on twentieth-acre plats, are briefly reported in a table. The most enduring varieties are stated to be meadow foxtail, wood meadow grass, rough-stalked meadow grass, various-leafed fescue, sheep's fescue, hard fescue, and red fescue. The mixtures of grass found to be most reliable in this locality are meadow foxtail, orchard

grass, and Kentucky blue grass, and meadow fescue, tall oat grass, and wood meadow grass.

Cooperative experiments.—Abridged reports are given of coöperative field experiments with fertilizers for oats, and on different modes of cultivating corn.

In the experiments with fertilizers for oats, superphosphate 400 pounds, dried blood and scrap 400 pounds, and barnyard manure 14 tons per acre, were each applied to 1 fortieth-acre plat; a fourth plat received no fertilizer. The average yield with each fertilizer is tabulated. The fertilized plats all gave an increased yield over the unfertilized plat, but the increase was nearly the same with each fertilizer, except that barnyard manure gave about 300 pounds more straw per acre than either of the other two.

Each experiment with corn was made on 4 tenth-acre plats. The corn, presumably for fodder, was planted on two plats in drills 3½ feet apart, with the kernels dropped in one case 2 and in the other 12 to the foot; and on the other two plats it was broadcasted at the rate of one half and 3 bushels per acre respectively. According to the average yield per acre, the largest yield occurred where the corn was broadcasted at the rate of 3 bushels per acre, and the next largest where it was sown in drills with 2 kernels to the foot.

Live stock experiments, C. A. Zavitz (pp. 186–201).—*Corn silage as a food for making beef.*—In this experiment three lots of grade steers, two steers in each lot, were fed from December 31 to April 29, the following rations daily:

Lot I. 12 pounds meal and silage *ad libitum.*
Lot II. 12 pounds meal, 45 pounds silage, and hay *ad libitum.*
Lot III. 12 pounds meal, 45 pounds turnips, and hay *ad libitum.*

The meal consisted of equal parts by weight of peas, barley, and oats.

The gains in live weight during the 119 days are tabulated as follows: Lot I: No. 1, 247 pounds; No. 2, 193 pounds. Lot II: No. 3, 222 pounds; No. 4, 220 pounds. Lot III: No. 5, 219 pounds; No. 6, 185 pounds.

The pecuniary results are not calculated.

Fattening lambs.—Forty-eight lambs, nearly all Cotswold and Oxford-Down grades were pastured in a field of rape from October 10 to December 10, and fed in a shed from December 10 to February 10 on sliced turnips, whole oats, and hay. One of the lambs died during the experiment. The lambs gained 864 pounds in live weight in the 2 months while at pasture and 544 pounds while fed in the shed. The lambs were sold for 5¾ cents per pound, realizing $185.60 over the first cost of the lambs October 10.

Corn silage and roots as food factors in swine feeding.—An experiment was made with pigs averaging 204.5 pounds each to test the value of corn silage and turnips. Three lots each containing a barrow and one

small and one large sow, were fed from January 10 to March 28 as follows:

Lot I received daily 16½ pounds of a mixture of one part each of wheat middlings and ground oats and three parts of pea meal; Lot II, 5½ pounds of the same mixture and 60 pounds sliced turnips; and Lot III, 5½ pounds of the mixture and 35 pounds of corn silage in place of the turnips. The 3 pigs in Lot I gained 270.5 pounds, those in Lot II 139.5 pounds, and those in Lot III 80.5 pounds live weight during the experiment.

Feeding swine on grain and meal.—To test the comparative feeding value for young pigs of (1) a mixture of 2 parts of ground peas and 1 part each of ground oats, ground barley, and wheat middlings; (2) a mixture of equal parts of peas and barley, ground; and (3) the same unground. These rations were each fed to one lot of pigs containing one full-bred and three grade Berkshires, averaging about 50 pounds each, from January 17 to May 31. The general health of the pigs receiving ration 1 was better than that of those on the other rations. Some of the latter became "stiffened" after a time, and in one case a change to lighter food was necessary.

The average amount of food eaten and the average gain in live weight per day are given for the pigs on each ration as follows:

Average per animal, daily.

Rations.	Food consumed.	Gain in live weight.
	Pounds.	*Pounds.*
I. Ground peas (2 parts), ground oats and barley, and wheat middlings.	3.07	1.35
II. Ground peas and barley	2.27	0.49
III. Whole peas and barley	2.36	0.21

Mixture No. 1 seems to have produced the best gains in live weight. The financial advantages of the several rations are not considered.

Green fodder as a food for swine.—Three lots of Berkshire pigs were fed from June 7 to October 8 the following rations respectively, the object being to test the value of green fodders (clover, oats, millet, and fodder corn at different times) as a substitute for part of the grain:

Lot I was given a grain mixture consisting of two parts of peas and one part each of barley, oats, and wheat middlings, *ad libitum.* In the case of Lot II, about one fourth and of Lot III, about two thirds of the grain mixture was replaced by green fodder. The results follow:

Food eaten and gains in live weight.

	Food consumed per animal daily.		Gain in live weight during experiment.		
	Grain.	Green fodder.	Pig 1.	Pig 2.	Pig 3.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Lot I	4.12		105	92	95
Lot II	3.09	1.85	43	79	100
Lot III	1.39	3.77	7	27	25

While the gain in live weight varies widely with the different pigs in Lots II and III, it is evident that the best results were secured where the full grain ration was fed, and the pigs in this lot (I) were in the best condition at the close of the experiment.

Soiling cows.—A trial with two cows "to determine how much land would be required to produce sufficient food for them during the summer season." The food consisted of permanent pasture, first and second growth clover, alfalfa, peas, and oats. From June 10 to September 26 the food consumed by the two cows was cut from an area of 1.56 acres, or 0.78 acres per animal.

Feeding steers of different breeds.—A record of progress in an experiment to compare "the merits of the grades of the principal breeds of cattle in Ontario for beef production."

Berkshire vs. Improved Yorkshire pigs.—A record of one young pig of each breed fed on milk and a grain mixture during 5 months. During this time the Berkshire ate 30 pounds more grain and gained 12.5 pounds more than the Improved Yorkshire.

Feeding experiments with hogs, G. Harcourt (pp. 206–211).—Several experiments are reported which were made to ascertain the amount of food required to produce a pound of gain in pigs of different weights, and to test the value of wheat bran for pigs. The results of the latter trial indicate that bran in connection with skim milk and buttermilk is a good food for hogs. "In these experiments we notice a steady increase, as the animals get older and heavier, of the amount of food required to lay on 1 pound of flesh. * * * Young pigs are the cheapest to feed and should be turned off about the time they attain a weight of 150 pounds live weight, as the least amount of food, as a rule, will then be required to produce a pound of flesh."

Fodder corn and the silo, G. Harcourt (pp. 211–218).—*Method of seeding.*—An experiment is reported in which Pearce Prolific corn was grown for silage in drills 3, 3½, and 4 feet apart, using from 35 to 15 pounds of seed per acre. The largest yield was realized where 15 pounds of seed per acre were sown in drills 4 feet apart, and the next largest with 18 pounds of seed per acre and drills 3½ feet apart.

Varieties of corn.—Tabulated data for 44 varieties.

Growth of corn.—The average growth of the leaves and tassels of corn during August is tabulated for 28 plants. The author concludes that, "all other things being equal, the rapidity of growth depends on the weather. This was noticed very markedly. A fine, hot day always resulted in a very rapid growth—as high as 3 inches in the 24 hours, and in one or two cases as high as 5 inches. If the day was cold the growth was very slow, in some cases none at all. The growth during the night was *nil.*"

Proceedings of the Ontario Agricultural and Experimental Union (pp. 221–262).—The eleventh annual meeting of the Union was held at the Ontario Agricultural College, January 6 and 7, 1890. The annual

address of the President was delivered by J. A. Craig. Papers were presented on the following topics: The Mineral Exhaustion of Soils, by A. E. Shuttleworth; Barns for Ontario, by J. B. Bowes; The Scientific Principles Underlying the Making and Feeding of Corn Silage, by C. C. James; Chemistry of Dairy Products, by A. E. Rennie; Corn and Hogs as Source of Profit in Farming, by B. Robinson; The Farmer's Son before and after a Course at College, by J. B. Muir; The Need and Uses of Experimental Work in Dairying, by J. W. Robertson; Barley Growing in Ontario, by T. G. Raynor.

Determination of fat in milk, C. C. James (*Ontario Agr. College Expt. Sta. Bul. No.* 61, *April* 15, 1891, *pp.* 6).—This is a description of the Babcock centrifugal method of determining the percentage of fat in milk, together with a report on the accuracy of the results obtained from this method. In four comparisons with gravimetric methods, the widest variation was 0.11 per cent. A test of milk while fresh and after standing until very sour gave the same results (3.6 per cent) of fat. "If the bottles are accurately graduated and the instructions followed, I consider the method exceedingly satisfactory." Illustrative of the use which may be made of the method, the average composition for one week of the milk of each of six cows used in a feeding experiment, is appended.

The author suggests a modification of the method by adding 3 c. c. of a mixture of amyl alcohol and hydrochloric acid at the time the sulphuric acid is added, and whirling the bottles at ordinary temperature, instead of filling the water jacket with hot water. This change makes the method practically the same as the Vermont Station method, as he uses in some cases the Beimling centrifugal.

Bark louse and pear tree slug, J. H. Panton (*Ontario Agr. College Expt. Sta. Bul. No.* 62, *April* 25, 1891, *pp.* 7, *figs.* 9).—Brief notes on the oyster-shell bark louse (*Mytilaspis pomorum*) and pear tree slug (*Selandria cerasi*), with suggestions as to remedies.

Pitting the sugar beet, C. C. James (*Ontario Agr. College Expt. Sta. Bul. No.* 63, *May* 15, 1891, *pp.* 8).—This includes brief general statements regarding the preservation of sugar beets in winter, a description of the earth pits or silos used in Europe for the storage of beets, and short records of experiments at the station in storing beets in a similar pit. The sugar beets grown at the station in 1890 were stored in a pit from harvest until March 12, 1891. "Shortly afterwards the beets were fed to the stock. In general appearance the beets seemed about the same as when first pitted, except that sprouting had taken place in some." The analyses of 12 samples from the pit gave an average of 12.54 per cent of sugar in the juice with a purity coefficient of 82.20, as compared with an average of 14.77 per cent of sugar and a purity coefficient of 81.97 for 53 samples analyzed soon after harvesting.

Allowing for any errors in sampling, we can safely conclude that the beets lost about 2 per cent of sugar in the silo; that the coefficient of purity, however,

remains about as before; and that the beets, even after being preserved 5 months in a simple earth silo, came out in a condition very favorable to the production of sugar. There seems to be no doubt that in this province the sugar beet can be preserved as long as necessary through our winter months in a condition suitable for sugar making.

The following are analyses of beets from the pit as compared with turnips and mangel-wurzels from the farm root cellars, all samples being taken near the end of March, with a view to determining their value for stock feeding.

Composition of sugar beets, turnips, and mangel-wurzels.

	Water.	Crude protein.	Crude fat.	Carbohydrates.	Crude fiber.	Crude ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
(1) Dry:						
Sugar beets		9.03	0.67	80.39	6.09	3.82
Turnips		11.89	1.35	73.73	8.57	4.46
Mangel-wurzels		17.69	0.91	67.98	6.44	6.98
(2) As fed:						
Sugar beets	82.93	1.54	0.11	13.73	1.04	0.65
Turnips	87.09	1.54	0.17	9.53	1.10	0.58
Mangel-wurzels	91.00	1.59	0.08	6.12	0.58	0.63

Silage and roots for swine. T. Shaw (*Ontario Agr. College Expt. Sta. Bul. No.* 64, *May* 28, 1891, *pp.* 8).—This experiment, the object of which was "to ascertain the value of corn silage and roots as food adjuncts in feeding swine in the winter season" and "to demonstrate the extent of the loss for feeding swine after they have become fit for slaughter," was made with 9 Berkshire pigs about 7 months old and averaging about 150 pounds in weight at the commencement of the experiment. They were divided into three lots (one barrow and two sows in each) which were fed from December 4, 1890, to March 4, 1891, 90 days, as follows: Lot 1 were fed all they would eat, about 4.5 pounds each per day, of a grain mixture composed of two parts by weight of ground peas and one part each of ground oats, ground barley, and wheat midlings; lots 2 and 3 were each fed about one half as much of the same grain mixture as lot 1, lot 2 receiving turnips, and lot 3 silage, *ad libitum*. The pigs of lot 2 consumed on an average about 13.7 pounds of turnips, and those of lot 3 about 6.9 pounds of silage each per day. The silage was cut into pieces about 1½ inches long. Only the more succulent portions were eaten, the other portions being merely chewed. In estimating the pecuniary results the grain mixture was valued at 1 cent per pound, the turnips at 8 cents per bushel, and the corn silage at $2 per ton, and no mention is made of any allowance being made for the value of the manurial residue.

At the close of the feeding lot 2 (grain and turnips) were "not in prime condition," and lot 3 (grain and silage) were not in much better condition than at the beginning of the feeding.

The pigs were all valued at the beginning of the experiment at $3.75 per hundred pounds live weight. At the close the price of pork was

somewhat higher and lot 1 were valued at \$4.50, lot 2 at \$4.15, and lot 3 at \$4 per hundred live weight. The average results are tabulated. These show that while the three pigs in lot 1 (grain alone) made an aggregate gain in live weight of 263 pounds during the 90 days, those of lot 2 (grain and turnips) gained only 163.5 pounds, and those of lot 3 (grain and silage) only 71 pounds. The increase made by lot 1 was valued at \$3.08 more than the first cost of the food eaten; and that made by lot 2 at \$2.59, and by lot 3 at \$4.08 less than the cost of the food.

At the close of the above experiment the three lots were fed for 47 days longer, each being given alike all they would eat of the grain mixture. The animals averaged at this time from 180 to 240 pounds each in live weight. The average increase in live weight per animal during this after feeding was, lot 1, 6.7 pounds; lot 2, 43.7 pounds; and lot 3, 73.3 pounds. At the close of this experiment the animals were all slaughtered. At 4½ cents per pound of live weight produced the value of the increase was only sufficient in the case of lot 3 to cover the first cost of the food.

The conclusions of the author that "pigs should be finished for market at an early age to get the best results," are in accordance with those reached elsewhere.

Ginseng, J. H. Panton (*Ontario Agr. College Expt. Sta. Bul. No.* 65, *June* 15, 1891, *pp.* 7, *fig.* 1).—A brief description of ginseng (*Aralia quinquefolia*), with statements regarding its cultivation and distribution. This plant is exported in large quantities to China, where it is used for medicinal purposes. Canada alone is stated to have exported the roots of this plant to an amount valued at \$100,000 in 1890, and the legislature of Ontario at its last session passed an act, the text of which is given, forbidding the gathering of the roots of ginseng in uncultivated land between January 1 and September 1.

EXPERIMENT STATION NOTES.

Delaware College.—W. H. Bishop, B. S., formerly of Tougaloo University, Mississippi, has been appointed professor of agriculture in the Delaware College.

Georgia Station.—The station has completed a four-room building for office purposes, and now has in process of erection a two-story building 32 by 48 feet to serve for ginnery, farm machinery and implements, and a dairy 16 by 20 feet with a cellar 12 by 12 feet in the center of which is a well. The series of experiments in hybridization and cross-fertilization of species and varieties of cotton commenced last year, is still in progress and promises interesting results. Varieties of cotton from Egypt, central Asia, India, and South America enter into the experiments. Flowers of *Gossypium* pollinated with pollen from okra (*Hibiscus esculentus*) resulted in apparently perfect bolls of cotton, but the seed when planted in 1891 failed in every instance to germinate. On the other hand when okra was used on the female parent the resulting seed germinated as usual, but the plants were identical in appearance with the original okra parent plant, with the exception that the period of blooming and fruiting was very greatly delayed.

Illinois Station.—S. H. Peabody, Ph. D., LL. D., resigned his position as president and member of the board of direction of this station August 7, and George E. Morrow, M. A., was elected in his place.

Iowa Station.—Feeding experiments are in progress at this station with soaked corn for Poland China, Chester White, and Jersey Red pigs, and Shropshire lambs, and comparative tests of soiling crops and pasturage. Seven breeds of sheep and twenty head of steers, representing three different breeds, have been obtained for the purpose of conducting feeding experiments. A forthcoming bulletin of the station will contain among other things reports of a feeding experiment with gluten meal, and comparative tests of "sugar meal" *vs.* corn meal, and skim milk *vs.* whole milk.

Mississippi Station.—Tait Butler, D. V. S., has been appointed veterinarian to the Mississippi Station.

Pennsylvania Station.—J. W. Fields has been appointed assistant chemist vice H. B. McDonnell, M. D.

Virginia College and Station.—J. M. McBryde, Ph. D., LL. D., has been appointed director of the station and president of the college vice W. D. Saunders, resigned, and entered upon his duties August 1. The organization of the station is at present as follows: J. M. McBryde, Ph. D., LL. D., president of the college and director; R. J. Davidson, M. A., acting chemist; T. L. Watson, assistant chemist; E. A. Smyth, jr., M. A., botanist; W. B. Alwood, horticulturist, entomologist, and mycologist; R. H. Price, assistant horticulturist; D. O. Nourse, agriculturist and farm superintendent.

Wyoming Station.—The director of the station, D. McLaren, M. S., has made an extended tour of the State, with special reference to the agricultural and grazing interests, and has visited the experiment farms at Lander, Laramie, Saratoga, Sheridan, Sundance, and Westland. The aims and methods of the experiment station have been explained to meetings of farmers in various parts of the State.

GERMANY.—The sixty-fourth convention of the Association of German Naturalists and Physicians will be held at Halle from September 21 to 25, 1891.

The sections of the Association include those for physics, chemistry, botany, physiology, pharmacology, pharmacy and pharmacognosy, hygiene, agricultural chemistry and experimentation, and scientific instruments and apparatus.

The president of the section for agricultural chemistry and experimentation is Professor Maercker, director of the experiment station of the Central Agricultural Society of the Prussian Province of Saxony at Halle. The program for this section is not yet complete, but it is expected that papers will be presented, among others, by Professors Maercker, Hellriegel of Bernburg, Nobbe of Tharand, and Albert of Halle, the subjects of which have not yet been announced; by R. W. Bauer on (*a*) Normal Soil, (*b*) Field Experiments on Sandy Plains, and (*c*) The Sugar of the Fruit of the Dog Rose; and the following by Professor Maercker's assistants: Dr. Morgan, The Adulteration of Thomas Slag; Dr. Cluss, The Application of Hydrofluoric Acid in the Brewing Industry; and Dr. Gerlach, The Solubility of the Phosphoric Acid of the Soil, and its Relation to the Yield.

It is expected that Professor Atwater of this Office, will attend the meeting of the Association, and will furnish for the Record a report of the proceedings as far as they are of interest to agriculture.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING AUGUST, 1891.

DIVISION OF ORNITHOLOGY AND MAMMALOGY:

North American Fauna, No. 5.—Results of a Biological Reconnoissance of South-Central Idaho; Descriptions of a New Genus and Two New Species of North American Mammals.

DIVISION OF STATISTICS:

Report No. 87 (new series), August, 1891.—Report of the Condition of Growing Crops; Freight Rates of Transportation Companies.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 1, August, 1891.

Miscellaneous Bulletin No. 3.—Proceedings of the Fourth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING AUGUST, 1891.

AGRICULTURAL EXPERIMENT STATION OF FLORIDA:

Bulletin No. 13, April 1, 1891.—Irish Potatoes, Rye, and Fertilizers.

GEORGIA EXPERIMENT STATION:

Special Bulletin No. 12½, July, 1891.—Circular to the Farmers of Georgia from the Board of Directors.

Bulletin No. 13, July, 1891.—Analyses of Feeding Stuffs; Forage Plants.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Third Annual Report, 1890.

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 40, July, 1891.—Weather Record April–June; some Diseases of Lettuce; Fertilizer Analyses; Feeding Experiments with Steers.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 31, July, 1891.

MISSOURI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 15, July, 1891.—Tests of Varieties of Wheat and Oats; Change of Seed of Wheat, Oats, and Potatoes.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 78, July 10, 1891.—Some Injurious Insects.

Bulletin No. 77*b*, July 1, 1891.—The Injury of Foliage by Arsenites; a Cheap Arsenite; Combination of Arsenites with Fungicides.

Bulletin No. 75*c*, April 28, 1891.—Meteorological Summary for North Carolina, February and March.

OHIO AGRICULTURAL EXPERIMENT STATION:

Ninth Annual Report, 1890.

THE PENNSYLVANIA STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, July, 1891.—Culture of the Chestnut for Fruit; Analysis of Several Varieties of Chestnuts.

TEXAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 15, May, 1891.—Influence of Climate on Composition of Corn; Digestibility of Food Stuffs; Miscellaneous Analyses.

Bulletin No. 16, June, 1891.—Work in Horticulture; Drainage Experiments.

AGRICULTURAL EXPERIMENT STATION OF UTAH:

Bulletin No. 7, July, 1891.—Draft of Mowing Machines.

VIRGINIA AGRICULTURAL AND MECHANICAL COLLEGE EXPERIMENT STATION.

Bulletin No. 10, June, 1891.—Steer and Pig Feeding.

WYOMING AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 2, August, 1891.—Plant Lice.

DOMINION OF CANADA.

ONTARIO AGRICULTURAL COLLEGE EXPERIMENT STATION:

Bulletin No. 67, August 12, 1891.—Winter-Wheat Experiments.

BUREAU OF INDUSTRIES, TORONTO, ONTARIO:

Bulletin No. 37, August 8, 1891.—Crops and Live Stock in Ontario.

EXPERIMENT STATION RECORD.

Vol. III. ISSUED OCTOBER, 1891. No. 3.

EDITORIAL NOTES.

The Association of American Agricultural Colleges and Experiment Stations held its fifth annual convention August 12–18 at Washington, District of Columbia, in the lecture rooms of the Columbian University. There were present 125 delegates and representatives of colleges and stations in 37 States and Territories, and of the United States Department of Agriculture. About the same time occurred the meetings of the American Association for the Advancement of Science, the Association of Official Agricultural Chemists, the Society for the Promotion of Agricultural Science, the Association of Economic Entomologists, and the Conference of American Chemists.

A salient feature of the convention of colleges and stations was the lectures of Mr. R. Warington, F. R. S., chemist of the experiment station at Rothamsted, England. This course of six lectures was the first to be delivered under the provisions of the Rothamsted trust, instituted by Sir John Bennet Lawes, and referred to in a previous number of the Experiment Station Record (see vol. III, p. 73). The subjects treated were: The Rothamsted Experimental Station; the circumstances which determine the rise and fall of nitrogenous matter in the soil; nitrification; nitrification and denitrification; nitrification of soils and manures; drainage and well waters. Mr. Warington's description of the work of the Rothamsted Station and his more detailed accounts of the processes and results of the investigations of problems of nitrification were followed with much interest by the scientists present, and will constitute a valuable contribution to the literature of scientific investigations in agriculture. A full report of these lectures and of the proceedings of the convention will be issued as bulletins of this Office at an early date.

Dr. H. H. Goodell, president of the Massachusetts Agricultural College and director of the Massachusetts Hatch Station, presided at the session of the first day of the convention, but was afterwards compelled

by indisposition to yield the chair to Vice Presidents Roberts of New York and Porter of Missouri for the remainder of the meeting. In his annual address President Goodell urged the necessity for untiring patience and perseverance in scientific research in order to attain the highest success, enforcing his argument with illustrations from the lives of eminent workers in general and agricultural science and from the carefully planned and thoroughly executed experiments conducted for so many years by the Rothamsted Station.

In accordance with the plan adopted by the Association, the section on agriculture presented two topics deemed of general interest to the convention. The first was the question, "How can the results of station work be most successfully presented to the farmer?" The leaders in the discussion of this question were Director Roberts of New York and President Scott of New Jersey. Mr. Roberts urged that the station worker make himself thoroughly familiar with the environment and life of the average farmer. Since the work of the farmer was so exacting as to leave him but little time and strength for reading, the station bulletins should be attractive in appearance, brief in form, and simple in language. Well-executed illustrations would greatly enhance the popularity and practical benefits of these publications. Mr. Scott laid special emphasis on personal contact of the station worker and the farmer as a means of inducing the latter to apply the information gained by scientific research in the improvement of agricultural methods and products. He outlined a plan about to be put into execution by the New Jersey Station for sending lecturers throughout the State to address the farmers at meetings of their various organizations.

Another topic was presented by Professor Morrow of the Illinois College and Station, in a paper on the relations which should exist between the investigator and the teacher. In his opinion these two classes of workers might do each other and the cause of agricultural science a great service by cultivating relations of mutual helpfulness. The teacher should know what is going on in the laboratory and field so that he might be able to bring to his pupils new truths or fresh illustrations of old ones. The investigator, on the other hand, needed to know the difficulties and questionings which presented themselves in the class room with reference to the problems he was investigating. By this means he would be better able to learn how to state processes and results of his researches so as to make his reports clear and satisfactory.

The report of the executive committee, covering a period of nine months ending August 12, 1891, was submitted by its chairman, President Alvord of Maryland.

The report of the section on botany, presented by Professor Halsted of New Jersey, showed that the station botanists had been especially active in studies on the diseases of plants and their prevention, and that results of much practical importance had followed their investigations.

In the report of the section on chemistry, presented by Director Neale of Delaware, the work of the station chemists was classified under the following heads: (1) Detective duty, (2) agricultural manufactories, (3) work of immediate value in directing farm management, (4) development of analytical methods and invention of apparatus, (5) investigations of interest chiefly to students and scientists. The report also urged the desirability of coöperation among the workers in different branches of agricultural science in order that the practical ends, which were the real object of experiment station work, might be most speedily and effectually attained.

The report of the secretary and treasurer, Director Scovell of Kentucky, showed that at the adjournment of the Champaign convention in November, 1890, the indebtedness of the Association amounted to $1,190.19, and that the expenses incurred by the executive committee during the year were $216.84, making the total liabilities of the Association for this period $1,407.03. The amount received during the year was $1,716.52, leaving a cash balance of $309.49 in the treasury of the Association.

The report of the committee on a coöperative station exhibit at the World's Columbian Exposition was presented by Director Armsby of Pennsylvania. From this it appeared that much interest in the project has been manifested by the stations, and that they thoroughly appreciate the value of the opportunity afforded by the Exposition to bring their work prominently before the public. Favorable responses to circulars describing plans for the proposed exhibit had been received from nearly all the stations. The plan for the exhibit proposed by the committee was accepted, and it was voted to continue the committee until the close of the Exposition. The action of the convention, taken in connection with the favorable replies which the committee has received from the stations, gives assurance that the exhibit will be both creditable to the stations and instructive to the public. A special committee was appointed to coöperate with the World's Congress Auxiliary in relation to an agricultural congress to be held during the Exposition as one of a series of congresses on scientific, educational, and social subjects.

The question, What coöperation is desirable between the colleges and stations and the Weather Bureau of the Department of Agriculture? was discussed by Assistant Secretary Willits and others. Communications from Prof. M. W. Harrington and Major H. W. Dunwoody of the Weather Bureau were read in this connection. As the outcome of this discussion, a committee, consisting of Messrs. Smith of Minnesota, Harris of this Office, and Alvord of Maryland, was appointed to consider the whole subject. This committee subsequently reported the following resolutions, which were adopted:

Resolved, That in the future development and extension of the Weather Bureau in the special interests of agriculture, the Bureau should organize and assist in maintaining a study of climatology in its relations to farming, in coöperation with

agricultural colleges and stations; and that the sphere of this work should be enlarged to include the physics, conditions, and changes of agricultural soils.

Resolved, That a special committee be appointed by this Association to confer with the officials of the Department of Agriculture in furthering the object stated and in bringing the same to the attention of Congress.

Messrs. Alvord, Harris, and Henry of Wisconsin were appointed as the special committee called for by this resolution.

Hon. William T. Harris, United States Commissioner of Education, addressed the convention regarding reports by the colleges and stations to the Bureau of Education under the act of Congress of 1890. He was requested to prepare and forward to the colleges and stations blank forms for these reports. A letter was received from Hon. Justin S. Morrill expressing his appreciation of the vote of thanks passed by the Association at its last convention for the services rendered by him in securing legislation relative to the colleges.

The following resolutions, among others, were agreed to:

Resolved, That a committee of three, especially representing the colleges of agriculture and mechanic arts, be appointed to consider the subject of a collective agricultural college exhibit in the agricultural building of the World's Columbian Exposition, and with power to represent the interests of the Association in this connection.

Resolved, That this Association renew its expression of sincere thanks to Sir John Bennet Lawes for his munificent provision for a course of lectures on the work done at Rothamsted, to be delivered biennially in the United States, and that it also wishes to express its sincere thanks to Mr. R. Warington for consenting to deliver the first series of lectures, and its appreciation of the high scientific and practical value of the course delivered at this meeting.

It was decided that no adjourned session of the convention should be held during the present year.

The following were elected officers of the Association for the ensuing year: President, W. L. Broun of Alabama; vice presidents, C. W. Dabney of Tennessee, J. W. Nicholson of Louisiana, H. E. Stockbridge of North Dakota, F. E. Emery of North Carolina, and W. H. Jordan of Maine; secretary and treasurer, M. A. Scovell of Kentucky; executive committee, H. E. Alvord of Maryland, H. H. Goodell of Massachusetts, J. A. Myers of West Virginia, W. Frear of Pennsylvania, and A. T. Neale of Delaware.

Section on agriculture: Chairman, C. L. Ingersoll of Nebraska; vice chairman, G. W. Curtis of Texas; secretary, T. F. Hunt of Pennsylvania. Section on botany: Chairman, G. F. Atkinson of Alabama; secretary, L. H. Pammel of Iowa. Section on chemistry: Chairman, M. A. Scovell of Kentucky; secretary, H. H. Harrington of Texas. Section on college work: Chairman, E. M. Turner of West Virginia; vice chairman, C. H. Pettee of New Hampshire; secretary, H. E. Stockbridge of North Dakota. Section on entomology: Chairman, L. Bruner of Nebraska; secretary, F. M. Webster of Ohio. Section on horticulture: Chairman, E. A. Popenoe of Kansas; secretary, T. L. Brunk of Maryland.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Connecticut State Station, Bulletin No. 108, May, 1891 (pp. 11).

EXAMINATION OF THE SEED OF ORCHARD GRASS (pp. 2–4).—The tabulated results are given of botanical analyses and germination tests made at the station of 17 samples of orchard-grass seed, 6 of which were bought of seedsmen in the State, 6 from Boston, and 5 from New York. The results of these examinations are summarized as follows:

Of the 17 samples 1 sample contained as much as 98.8 per cent of pure seed, the remainder being chaff. Another contained no orchard-grass seed whatever, and consisted mainly of *Lolium perenne*, or perennial rye grass. Excluding this sample, the other 16 samples contained on the average 77.4 per cent of pure seed.

Seven out of 16 samples contained notable quantities (from 8.3 to 35.5 per cent) of seed of perennial rye grass, which is less valuable and sells at a lower price. "Tested" orchard-grass seed is quoted at 11 cents per pound and tested perennial rye grass at 4½ cents. A single sample contained 14.1 per cent of a species of *Bromus*, probably *secalinus*, or chess.

In 1 sample as high as 88 per cent of the orchard-grass seed sprouted, in another as low as 4.5 per cent, and on the average of 16 samples 50 per cent.

Taking the 16 samples together, the average quantity of pure orchard-grass seed which was capable of sprouting was 40 per cent; *i. e.* out of every 100 pounds bought 40 pounds was pure, live seed. Probably the quantity that would produce healthy plants was less than this.

ASH ANALYSIS OF WHITE GLOBE ONIONS (pp. 4, 5).—Twenty-two fair-sized White Globe onions were selected from several barrels for analysis. The fresh onions contained 0.27 per cent of nitrogen and 0.48 per cent of ash. The composition of the pure ash and the calculated amount of ash ingredients in 1 ton of onions are given as follows:

Analysis of White Globe onions.

	In 100 parts of ash.	In 2,000 pounds of onions (bulbs).
		Pounds.
Nitrogen	....	2.70
Phosphoric acid	19.08	0.92
Potassium oxide	43.49	2.09
Sodium oxide	1.26	0.06
Calcium oxide	10.87	0.52
Magnesium oxide	4 46	0.21
Oxide of iron	1 07	0.05
Sulphuric acid	15.98	0.77
Chlorine	2.36	0.11
Sand and silica	1.96	0.09

THE DETERMINATION OF FAT IN CREAM BY THE BABCOCK METHOD (pp. 5-11).—This is a comparison of fifty samples of cream of the percentages of fat indicated by the Babcock centrifugal method and by the gravimetric method of the laboratory. In all except ten cases a pipette made by A. L. Winton, jr., which delivered quite accurately 6 grams of cream, was used in measuring the cream for the Babcock test. After measuring into the test bottles the cream was diluted with 12 c. c. of water, the test made as usual, and the reading of fat in the graduated tube multiplied by 3. This pipette is said to do away with the correction otherwise necessary in testing cream by this method. In 26 cases the Babcock method gave higher results and in 24 cases lower results than the gravimetric method. The greatest difference was 0.56 per cent. The difference between the two methods was in 18 cases a tenth of 1 per cent or less; in 35 cases it was less than a quarter of 1 per cent; and in 7 cases it exceeded a third of 1 per cent.

In considering these figures and the accuracy of the method it must be borne in mind that the per cent of fat is from four to six times as great in cream as in milk, and hence a larger difference in the percentage of fat found in cream by the two methods may not involve any larger proportion of the total quantity of butter fat than a much smaller difference in the per cent of fat found in milk by the two methods involves in the total quantity of the fat of milk.

The results above given lead us to believe that the Babcock method may be made of very great value to cream-gathering creameries. It offers to them a practical and accurate method of ascertaining the actual quantity of butter fat which each patron furnishes, so that payments may be based not on volume of cream supplied, but on actual butter fat, which is the raw material that the creamery manufactures. This is obviously the most satisfactory method of payment. For this purpose each patron's cream should be weighed and sampled, and the fat in it determined by the method described.

The station proposes, to study the practical working of this method at a creamery.

Delaware Station, Bulletin No. 13, July, 1891 (pp. 16).

LEAF BLIGHT OF THE PEAR AND THE QUINCE, F. D. CHESTER, M. S. (plates 2, figs. 3).—This includes a description of the effects of this disease on leaves and fruit, a brief account of the leaf-blight fungus (*Entomosporium maculatum*), formulas for the fungicides used in experiments by the author, and accounts of experiments in spraying diseased trees in four localities in Delaware. In the case of one of the experiments, where five applications were made between May 10 and July 21, the following percentages of sound fruit are reported for each fungicide used: Modified eau celeste 85.1, Bordeaux mixture 81.4, precipitated carbonate of copper 80.8, ammoniacal carbonate of copper 78.3, carbonate of copper and carbonate of ammonia 66.3, no fungicide 42.

So far as the effect of the several mixtures upon the preservation of the foliage is concerned, there seemed to be no appreciable difference in their efficiency. * * *

The relative cost of the materials in these several fungicides was during the season of 1890 as follows, per 100 gallons: Carbonate of copper and carbonate of

ammonia mixture 25¼ cents, precipitated carbonate of copper 34 cents, modified eau celeste 40 cents, ammoniacal carbonate of copper 57¾ cents, Bordeaux mixture $1.51.

These costs were based upon the following market quotations per pound: Sulphate of copper 5¾ cents, salsoda 1¼ cents, strong ammonia (26°) in carboys 7 cents, copper carbonate (home manufacture) 14 cents, carbonate of ammonia 10 cents.

In another experiment 1.000 pear trees were sprayed four times during the season with Bordeaux mixture, at a total cost for labor (4 days at 75 cents) and the fungicide of $22, or 2.2 cents per tree. In an experiment with quinces the ammoniacal compound of copper did not give good results, but when the Bordeaux mixture was used the progress of the disease was staid. The author concludes in general that his experiments teach:

(1) That the ammoniacal carbonate of copper, the modified eau celeste, the carbonate of copper and carbonate of ammonia mixture, and the Bordeaux mixture will all control the leaf blight of the pear and prevent the fall of the foliage.

(2) That the ammoniacal carbonate of copper when used in excess is apt to injure the foliage and produce a russeted appearance of the fruit.

(3) That the carbonate of copper and carbonate of ammonia has this effect to a less degree, that it is cheaper and equally if not more effective.

(4) That the Bordeaux mixture is too expensive and troublesome a mixture, except in very serious cases.

(5) That the modified eau celeste, and the carbonate of copper and carbonate of ammonia mixture are the two cheapest as well as most effective fungicides for the treatment of this disease.

Florida Station, Bulletin No. 13, April 1, 1891 (pp. 28).

EXPERIMENTS WITH POTATOES AND RYE, J. P. DEPASS (pp. 4–8).—A brief account is given of an experiment with composts and commercial fertilizers on Beauty of Hebron and Burbank potatoes planted January 31. This experiment was in continuation of that reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 491).

The first of a series of experiments with rye grown for green forage in the winter is also reported. The rye was planted broadcast and in drills on three plats, on poor, sandy soil fertilized with manure and commercial fertilizers. On one plat the crop was cut for fodder and on another seven cattle and two colts were pastured. A considerable amount of green forage was easily and cheaply produced during the winter and early spring.

COMPOSITION AND VALUE OF CERTAIN MATERIALS FOR FERTILIZING PURPOSES, J. M. PICKELL, PH. D., AND J. J. EARLE, B. A. (pp. 9–28).—This article contains analyses of soft marl phosphate, and a discussion at considerable length of its value as a fertilizer; an account of an experiment made at the Connecticut State Station on the comparative value of finely ground and acidulated phosphates, taken from the Annual Report of that station for 1889 (see Experiment Station Record, vol. II, p. 483); analysis of a low-grade phosphate containing much

alumina, and of the same after treatment with sulphuric acid; analyses of a number of samples of muck, and a comparison of the average composition of the same with barnyard manure (average of 21 analyses made by the Massachusetts State Station); remarks on the methods of using muck, directions for composting, etc. Analyses are also given of bat guano and rice hulls, the latter with reference to its food ingredients.

The muck contains a great deal more nitrogen and much less potash and phosphate than the barnyard manure.

The muck contains comparatively much nitrogen, but is deficient in potash and phosphate. Hence in the use of muck as a fertilizer one should expect that it would need to be supplemented by potash and phosphate. * * *

Fifteen samples of our muck when perfectly dry contained between 56 and 97 per cent of organic matter, 12 of the 15 contained from 2 to 4 per cent of nitrogen, 3 less than 2 per cent, and 1 less than 1 per cent. Five samples contained less than 55 per cent of organic matter, 4 of which contained between 1 and 2 per cent of nitrogen, and 1 less than 1 per cent.

As is well known, plants of different kinds and different parts of the same plant contain different amounts of plant food. In the perfectly dry state, pea vines, for example, contain about 2 per cent of nitrogen, and wheat straw only about 1 per cent. One would naturally expect that a muck if formed by the disintegration of the former would contain more nitrogen than if by that of the latter. * * *

In judging of the value of a muck, three things at least are to be taken into account: (1) The kind or kinds of plants from which formed; (2) the quantity of organic matter in the muck; and (3) the stage of decomposition.

Georgia Station, Bulletin No. 12½, July, 1891 (pp. 8).

CIRCULAR TO THE FARMERS OF GEORGIA FROM THE BOARD OF DIRECTORS (pp. 55–60).—This special bulletin contains general statements regarding the history, organization, funds, publications, and work of the station, published with a view to increasing the interest of the farmers of the State in the work of the station.

Georgia Station, Bulletin No. 13, July, 1891 (pp. 12).

ANALYSES OF FEEDING STUFFS, H. C. WHITE, PH. D. (pp. 61–65).—This includes a study of the composition of six different varieties of sorghum and of pearl millet at different stages of growth; analyses of the kernels, cob, and stover of Brazilian flour corn; of the tubers and vines of five varieties of sweet potatoes; and of the plant, fruit, and parts of the fruit of Spanish and Georgia peanuts. The analyses are given as follows:

Percentage composition of sorghum and pearl millet.

	Amber cane.	White millo maize.	Yellow millo maize.	Kaffir corn.	Rural Branching sorghum.	Link Hybrid sorghum.	Pearl millet.
Cut when in bloom.							
Water	43.62	45.20	50.18	51.76	41.14	47.20	49.50
100 parts of dry matter contained:							
Crude protein	6.94	5.23	8.31	6.25	8.26	8.35	4.94
Nitrogen-free extract	45.65	46.96	45.66	36.24	41.42	43.21	44.53
Crude fiber	35.85	37.46	34.25	46.67	39.33	36.36	39.70
Crude fat	5.92	5.20	4.12	4.24	5.25	5.70	4.11
Crude ash	5.64	5.15	7.66	6.60	5.74	6.38	6.72
Seeds in the dough.							
Water	41.70	38.65	43.24	52.10	50.15	38.60	39.80
100 parts of dry matter contained:							
Crude protein	5.44	4.87	4.92	5.30	4.60	3.93	4.94
Nitrogen-free extract	55.26	55.90	51.79	41.98	50.36	52.84	44.40
Crude fiber	29.21	30.30	34.50	43.91	35.11	33.20	39.70
Crude fat	5.03	4.15	3.72	3.80	4.11	4.60	4.24
Crude ash	5.06	4.78	5.07	5.01	5.82	5.43	6.72
Seeds ripe, heads.							
Water	20.15	19.86	21.32	24.18	20.20	19.90	*25.60
100 parts of dry matter contained:							
Crude protein	8.81	9.93	11.45	11.12	10.35	11.38	5.80
Nitrogen-free extract	73.16	65.10	65.30	63.00	64.76	65.23	46.58
Crude fiber	11.05	17.34	14.66	17.36	16.32	15.40	38.65
Crude fat	3.86	3.28	4.27	5.14	4.86	4.32	3.15
Crude ash	3.12	4.33	4.12	3.38	3.71	3.67	5.82
Stalks.							
Water	35.71	36.36	38.41	32.85	37.61	35.40	(*)
100 parts of dry matter contained:							
Crude protein	4.56	3.72	3.15	6.75	3.11	2.88	....
Nitrogen-free extract	55.95	61.10	61.04	40.40	58.95	62.00	....
Crude fiber	30.11	27.22	28.73	44.55	30.24	27.45	....
Crude fat	5.12	3.20	2.34	2.19	2.58	2.15	....
Crude ash	4.26	4.76	4.74	6.11	5.12	5.52	....

* The stalk and seed-head of pearl millet were cut together and analyzed as cut.

Composition of kernels, cob, and stover of Brazilian flour corn.

	Water.	100 parts dry matter contained—				
		Crude ash.	Crude cellulose.	Crude fat.	Crude protein.	Nitrogen-free extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kernels	13.28	3.26	2.26	2.87	12.53	79.06
Cob	11.25	10.87	41.59	1.01	1.66	44.87
Stover	34.62	6.11	29.42	1.76	6.38	56.33

The ear taken for analysis weighed 567 grains, of which the kernels weighed 446.51 grains, and the cob 120.49 grains; percentage of kernels 78.75, of cob 21.25.

[The low percentage of fat in the kernels as compared with Indian corn, and the exceptionally high percentage of ash in the cob are noticeable.]

Composition of sweet potatoes.

Variety.	Vines.						Tubers.						
		100 parts dry matter contain—						100 parts dry matter contain—					
	Water.	Crude ash.	Crude fat.	Crude cellulose.	Crude protein.	Nitrogen-free extract.	Water.	Crude ash.	Crude fat.	Crude cellulose.	Crude protein.	Total sugar.*	Nitrogen-free extract.†
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Early Jersey	46.32	9.70	4.77	32.20	9.08	44.75	71.26	4.14	1.02	4.80	6.60	9.08	74.36
Southern Queen	47.15	11.26	4.32	27.39	8.38	48.65	70.40	4.12	1.00	5.13	5.03	8.45	76.27
Georgia Yarn	41.55	9.90	3.62	23.26	13.12	50.10	72.32	3.25	0.96	4.01	3.73	9.09	78.96
Pumpkin Yam	39.82	......	......	......	......	......	73.26	3.34	0.84	4.11	4.72	9.23	77.76
Poplar Root	40.62	10.92	3.78	16.88	13.35	55.07	71.60	3.01	1.04	3.63	4.08	8.02	80.22

* Calculated as cane sugar. † Exclusive of sugar.

Analysis of the plant and fruit of Spanish and Georgia peanuts.

	Vines.				Kernel of the fruit.		Hull of the fruit.		Roots of vines.	
	Cut before blooming.		Cut when fruit was ripe.							
	Spanish.	Georgia.	Spanish.	Georgia.	Spanish.	Georgia.	Spanish.	Georgia.	Spanish.	Georgia.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Water	32.62	29.78	31.43	32.38	13.15	12.85	19.20	20.62	29.62	28.74
100 parts of dry matter contain:										
Crude ash	9.96	11.32	11.74	12.91	2.72	2.18	4.63	3.00	9.75	9.58
Crude cellulose	24.75	19.89	28.46	36.10	3.50	2.34	71.78	79.30	41.66	48.59
Crude fat	6.30	5.84	4.82	5.22	41.17	43.13	2.08	2.12	4.31	3.20
Crude protein	12.69	12.57	11.71	9.91	32.18	30.49	7.19	4.99	8.78	7.63
Nitrogen-free extract	46.30	50.38	43.77	35.86	20.43	21.86	14.32	10.59	35.50	31.00

The relative proportions of hull and kernel in the fruit were: Spanish peanuts, hulls 22 per cent, kernels 78 per cent; Georgia peanuts, hulls 27 per cent, kernels 73 per cent.

FORAGE PLANTS, G. SPETH (pp. 66–72).—A popular discussion of the desirability of raising forage plants to be fed out on the farm, and remarks on commercial fertilizers, green manuring, barnyard manure, the selection of forage plants, and the cultivation of sorghum, teosinte, and pearl millet.

Teosinte (*Euchlæna luxurians*) is one of the most promising forage plants. It resembles corn, growing to a height of 6 or 8 feet, forming a mass of slender, succulent stems, with long, narrow leaves. It is of slow growth in the beginning, but shoots forward rapidly under the influence of our hot sun. Two cuttings were made last year, producing over 38,000 pounds of green food per acre, which was greatly relished by all kinds of farm stock. It is more affected by drouth than the sorghums, and requires a richer soil to do its best. It rarely reaches full maturity in our climate, while further south it ripens and produces seed. It is planted like corn, at a distance of 4 or 5 feet.

Illinois Station, Bulletin No. 16, May, 1891 (pp. 28).

This bulletin contains, in addition to reports of pig-feeding experiments and an article on composite milk samples, a table of contents and index to Bulletins Nos. 1–16, issued between May, 1888, and May, 1891.

EXPERIMENTS IN PIG FEEDING, G. E. MORROW, M. A. (pp. 497–504).

Corn vs. corn and grass.—Brief reports are given of four separate trials with Poland-China pigs, averaging in the different trials respectively 45, 178, 128, and 61 pounds each in weight. In each trial separate lots of pigs received (1) corn *ad libitum* ("full feed") and pasturage; (2) pasturage and a "half feed" of corn, which was changed to a full feed later; and (3) corn alone. The lots in the different trials consisted of from 3 to 5 pigs each, and the feeding lasted from 10 to 14 weeks. All were given coal slack and salt. Those given corn alone were kept in pens free from vegetation; the others were in a blue-grass pasture. The tabulated data show for each trial only the totals and averages of the corn consumed, gain in live weight, and gain per bushel (56 pounds) of corn. These indicate that during the first 6 or 8 weeks of each trial, when one lot received only the half feed of corn with pasturage, the gain made and the rate of gain per bushel of corn were best in the case of the pigs on the full ration of corn, either with or without pasturage, averaging rather better with pasturage. But during the following month, when all received a full feed of corn, the lot which had previously had only a half feed of corn with grass in each case made the largest total gain and the largest gain per bushel of corn.

Gain from dry corn alone.—A tabulated summary is given for eleven different lots of pigs, varying in weight from 65.5 to 311 pounds, which were fed exclusively on shelled corn with coal slack and salt, for periods ranging from 7 to 84 days.

The largest gain was 16.81 pounds per bushel by two pigs averaging 311 pounds in the fourth week of pen feeding. These two pigs had been on grass, with access to the droppings from two corn-fed heifers. * * * For 4 weeks their gain was at the rate of 14.66 pounds per bushel. In only one other case was this equaled in a period of 4 weeks. Two pigs averaging 209.27 pounds, fed from April 29 to May 27, gained at the rate of 14.73 pounds per bushel. In no case did pigs make satisfactory gains after 6 or 8 weeks' feeding on corn alone. * * *

The food required to make 1 pound of increase in weight in these trials depended less on the weight and age of the pigs than on other conditions [*i. e.* on the duration of the feeding, previous feeding, general condition, etc.].

Soaked vs. dry corn.—Two trials were made in each of which two pigs were fed soaked corn and two others dry corn, with no other food.

The pigs fed soaked corn ate more and gained more than those fed dry corn. In one trial they gained more and in one less in proportion to food eaten than those fed dry corn. The differences were not great in either case.

Value of droppings from corn-fed cattle for pigs.—The gains in weight are recorded for pigs receiving no other food than pasturage and the droppings of steers fed liberally on corn. In no case was the gain large.

Apple pomace silage.—A trial of silage made from apple pomace as food for pigs resulted unsatisfactorily. "The pomace kept well, and chemical analysis of it showed an apparently good composition for feeding purposes, but the pigs ate very little of it."

The composition of the pomace silage was as follows:

Analysis of silage from apple pomace.

	Fresh.	Water-free.
	Per ct.	Per cent.
Water	44.36	....
Crude ash	2.09	3 75
Crude cellulose	12.72	22 85
Ether extract	7.33	13.17
Crude protein	4.75	8.16
Nitrogen-free extract	28.75	52.07
	100.00	100 00

*Includes the acids.

COMPOSITE MILK SAMPLES, E. H. FARRINGTON, M. S. (pp. 504–515, fig. 1).—This is in continuation of the work on the testing of milk at creameries, which was reported in Bulletin No. 14 of the station (see Experiment Station Record, vol. II, p. 565). In the investigation recorded in this article the use of composite samples in testing milk, as proposed by Patrick in Bulletin No. 9 of the Iowa Station (see Experiment Station Record, vol. II, p. 101), was the special subject studied. Separate tests were made by the Babcock centrifugal method of the milk brought by each of twenty patrons of a creamery for 7 consecutive days, as follows: The milk of each patron (1) was tested daily, and (2) a composite sample of the milk brought by each patron during the 7 days was tested at the end of that time, the composite sample being made up in two different ways—by taking one tenth of a quart of each day's milk, and by taking an amount each day proportional to the quantity of milk brought ($\frac{1}{1000}$, $\frac{1}{5000}$, etc.). To prevent these composite samples from souring, from 15 to 20 grains of a mixture composed of 2 ounces of corrosive sublimate, 2 ounces of fine salt, 8 ounces of powdered borax, and 1½ drams of aniline red was added to each jar. Other composite samples were made by taking one tenth of a quart each day, but these received no preservative. The milk in these latter samples became sour and curdled. It was found that by adding about a half teaspoonful of "powdered lye" (98 per cent caustic soda) to the sour milk it became "as thin and homogeneous as new milk" and could be accurately sampled.

The action of the lye on sour milk is hastened by adding it to the milk in small quantities so that the lye is dissolved. If one half a teaspoonful of the lye is thrown into the milk at once, it collects together in a hard lump, which is dissolved with difficulty. The whole process of thinning the thick sour milk with lye is aided by warming the milk at a temperature of 100° to 140° F., and letting it stand for an hour or more. The time and heat both help the solvent action. Pouring from one jar to another is also an important factor in getting the milk thoroughly mixed.

The results are given for the tests made each day, with the averages of these for the 7 days, and for the three sets of composite samples. The following comparison of the results by the different methods of sampling is taken from the bulletin:

Average percentage of fat in milk by different methods of sampling.

Patron.	Average of the seven daily tests.	Composite samples.		
		Equal amounts of milk each day, poisoned.	Amounts proportional to the amount of milk brought, poisoned.	Equal amounts of milk each day, not poisoned.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	3.62	3.6	3.6	3.6
2	3.71	3.8	3.7	3.7
3	3.75	3.7	3.7	3.7
4	3.63	3.8	3.6	3.7
5	3.95	4.0	4.1	4.1
6	3.64	3.7	3.6	3.7
7	3.82	3.9	3.8	3.8
8	4.10	4.1	4.0	4.1
9	4.30	4.3	4.4	4.3
10	4.16	4.2	4.2	4.3
11	3.96	4.0	3.9	3.9
12	4.52	4.6	4.6	4.6
13	4.22	4.4	4.4	4.4
14	3.77	3.9	3.9	3.9
15	3.82	3.8	3.9	3.9
16	3.77	3.8	3.8	3.8
17	3.63	3.7	3.6	3.7
18	3.71	3.8	3.7	3.7
19	4.11	4.0	4.0	4.1
20	3.90	4.0	4.0	3.9

It will be seen that the agreement of the several series of composite samples is very close, and that these results present only slight variations from the averages obtained by testing samples daily. It would seem therefore that (1) "in this trial, testing the composite sample once each week was practically as accurate as testing milk every day;" and that (2) "it is not necessary to use a poison for preserving the milk, but that satisfactory results can be obtained by allowing the composite sample to sour, and thinning the sour milk by use of 'powdered lye' when a test is to be made." The results of the tests each day show considerable variations in the same milk from day to day, so that by taking a single sample of each patron's milk once a week sufficiently accurate results would not be obtained.

Trials in which the sample of milk was taken by different means, as by dipping, by the "milk thief," by a small tube, and by a small tube inside the delivery tube "indicate that there is practically no difference in the methods of taking a sample of milk for testing, if proper care is

used." Determinations made of the casein in samples of milk of each of five cows taken daily for 1 week, and in composite samples representing the same milk, showed a close agreement between the two methods of sampling.

An illustrated description of an automatic pipette for measuring the acid for milk tests, which was given in Bulletin No. 14 of the station, is reproduced here, together with a brief account of a stand for holding composite sample jars.

Application of the composite test to the dairy.—The milk of each of five cows was tested for 1 week, both by determining the fat daily and by testing the composite samples. In the latter no preservative was used, but instead lye was added at the time of testing. The results, which are fully tabulated, are an additional confirmation of the approximate accuracy of the method of determining the average percentage of fat by composite samples.

Kansas Station, Third Annual Report, 1890 (pp. 20).

This includes a financial statement for the fiscal year ending June 30, 1890, abstracts of Bulletins Nos. 10–19, an outline of the work of the station in 1890, and an index to the station publications for 1890.

Louisiana Stations, Bulletin No. 10 (Second Series), (pp. 55).

SYSTEMATIC FEEDING OF WORK STOCK AS A PREVENTIVE OF DISEASE, W. H. DALRYMPLE, M. R. C. V. S. (pp. 232–244).—A popular discussion of the effects of improper feeding on the health of horses and mules.

SOME DISEASES OF FARM ANIMALS, W. H. DALRYMPLE, M. R. C. V. S. (pp. 245–283).—Popular statements regarding the causes, symptoms, and treatment of the following diseases: *Swine.*—cholera, mange, inflammation of the lungs, trichinosis, and "measles;" *sheep.*—foot rot, liver rot, parasitic diseases of the lungs, grub in the head, mange, and gid; *cows.*—parturient apoplexy, abortion, and mammitis.

Massachusetts State Station, Eighth Annual Report, 1890 (pp. 324).

This includes the details of two feeding experiments with milch cows, two with pigs, and one with young lambs; numerous field experiments; report of the mycologist; analyses of feeding stuffs, licensed commercial fertilizers, fertilizing materials, water, etc.; a compilation of analyses of various materials; and meteorological observations. The chemical work during the year includes some 1,300 analyses, about 400 of which were made for the Massachusetts Hatch Station and from 300 to 400 at the special request of farmers of the State.

FEEDING EXPERIMENTS WITH MILCH COWS, C. A. GOESSMANN, PH. D. (pp. 12–69).—"It was the main aim of our feeding experiments with milch cows during the years 1885–89 to test the relative feeding value of our current coarse fodder articles, such as English hay, rowen, fodder corn, corn stover, corn silage, and roots." Accounts of some of these experiments were given in the Annual Reports of the station for 1888 and 1889, and in Bulletins Nos. 32, 34, and 35 (see Experiment Station Bulletin No. 2, part I, p. 74, and Experiment Station Record, vol. I, pp. 77, 81, and 222, and vol. II, p. 572).

"During the past year we have changed the object of our feeding experiments with milch cows. Having made ourselves, as far as practicable, familiar with the feeding effect and general economical value of our current coarse home-raised fodder articles, it was decided to compare the feeding value of our prominent concentrated fodder articles (grains, brans, oil cakes, gluten meal, starch feed, etc.)."

(1) *New-process vs. old-process linseed meal* (pp. 15–39).—This was an experiment to compare the effects of like amounts of new and old-process linseed meal on the quantity, quality, and cost of the milk. The experiment was reported in somewhat less detail in Bulletin No. 38 of the station (see Experiment Station Record, vol. II, p. 277).

(2) *Green crops vs. English hay* (pp. 39–54).—This experiment was made with six grade cows in different stages of the milking period, to observe the effect of substituting green forage crops (vetch and oats or soja beans) for a part of the hay, the grain remaining unchanged. It lasted from July 12 to September 30, 1890. During this time the grain ration consisted of 3½ pounds each of corn meal, wheat bran, and new-process linseed meal per animal daily, and the "full ration" of hay was about 20 pounds per animal.

About three fourths of the hay in the ration was substituted by a mixture of green vetch and oats in the first period (July 12–August 1), and by green soja beans in the second period (August 12–September 1), each of the green foods being fed *ad libitum*. In the third period (September 10–30) a full ration of rowen hay (about 20 pounds per animal) was given. The cutting of the vetch and oats and soja beans was commenced as they were beginning to bloom and continued until they were nearly mature, though the stems were succulent when last fed. They were cut into pieces 6 to 8 inches long for feeding. From 50 to 60 pounds of vetch and oats and from 40 to 60 pounds of soja beans were consumed per animal daily, "the quantity decreasing in all cases towards the maturing of the crop, on account of the gradual increase of solid matter in the crop."

The results, including the analyses of the milk, are tabulated for each cow separately, together with the analyses of the corn meal, new-process linseed meal, wheat bran, vetch and oats, and soja beans fed, with reference to both food and fertilizing constituents.

Although the individual cows differed somewhat from each other in

the amounts of food consumed and milk produced while on the same ration, the general effect of the different rations was similar in all cases, so that the results for the six cows may be averaged for each period. The following table shows the averages per animal during each of the three periods. In calculating the net cost of food, corn meal was valued at $24, wheat bran at $20, linseed meal at $26.50, hay at $15, green vetch and oats at $2.75, and green soja beans at $4.40 per ton, and 80 per cent of the value of the fertilizing ingredients of the food was deducted from the first cost.

Yield of milk and cost of food per animal.

	Net cost of food per animal.	Yield of milk per animal.	Net cost of food per quart of milk.	Average dry matter consumed. per quart of milk.
		Quarts.	*Cents.*	*Pounds.*
Period I. Grain, hay, and vetch and oats	$2.54	200.6	1.27	2.75
Period II. Grain, hay, and soja beans	3.06	212.5	1.39	2.76
Period III. Grain and rowen hay	2.98	197.4	1.51	2.86

The analyses of milk show no considerable changes in composition which can be attributed to the influence of the different rations. The cows all slightly increased in weight during the experiment. The table indicates only slight differences in the average milk yield in the dry matter consumed, and cost of food per quart of milk in the several periods. The results in general seem to be slightly better during the first period, and are favorable to the green-fodder crops as compared with rowen hay. They are similar to the results obtained in previous experiments with green vetch, Southern cowpeas, and serradella, and lead the author to "recommend very highly the raising of any of the stated new fodder crops, either alone or as mixed crops, for the purpose of increasing the fodder resources of the farm during summer and autumn. They may serve as green fodder as well as hay; most of them have a higher nutritive ratio than either English hay, corn fodder, or corn stover; they tend to improve the soil chemically and physically; they yield liberal returns, and are, as a rule, highly relished by cattle."

Creamery record of the station for 1889 and 1890 (pp. 54–69).—This is a record for 1889 and 1890 of amounts, kinds, and market values of the feeding stuffs fed, the fertilizing ingredients of the same, the average composition of the milk, the cost of producing cream per quart and per space, the amount received for the same from a coöperative creamery, the calculated value of skim milk with whole milk at 3 cents per quart, the analyses of cream and butter fat, and the fertilizing constituents of cream. The methods used at the station in the analysis of dairy products are fully described. The feeding stuffs given consisted of the ordinary grain feeds, hay, corn fodder, stover and silage, roots, and numerous green fodders. The following statements are from the author's conclusions:

Total cost of food for 1 quart of cream amounted in 1889 to 11.00 cents, and in 1890 to 13.75 cents.

The net cost of food per quart of cream averaged in 1889, 6.9 cents, and in 1890, 6.05 cents. We received per quart of cream in 1889, 11.69 cents, and in 1890, 11.46 cents, thereby securing a profit of 4.79 cents in 1889, and 5.41 cents in 1890.

FEEDING EXPERIMENTS WITH LAMBS, C. A. GOESSMANN, PH. D. (pp. 70–90).—This is a more detailed account of an experiment reported in Bulletin No. 37 of the station (see Experiment Station Record, vol. I, p. 231).

FEEDING EXPERIMENTS WITH YOUNG PIGS, C. A. GOESSMANN, PH. D. (pp. 91–112).—When experiments in pig feeding were commenced in 1884, the question proposed for study was as to the most profitable utilization of skim milk and buttermilk. In the experiments on this subject two conditions have been considered, (1) a large supply of either skim milk or buttermilk, and (2) a limited one.

In considering the first condition, the plan has been to mix corn meal with the skim milk or buttermilk in the following proportions:

Live weight of animal:

20 to 70 pounds .... 2 ounces corn meal per quart of milk.
70 to 130 pounds .... 4 ounces corn meal per quart of milk.
130 to 200 pounds .... 6 ounces corn meal per quart of milk.

Where the supply of buttermilk and skim milk has been limited, the milk has been supplemented by the following grain mixtures extended with water:

Live weight of animal.	Grain mixture (parts by weight).		
	Gluten meal.	Wheat bran.	Corn meal.
20 to 70 pounds	2	1	....
70 to 130 pounds	1	1	1
130 to 200 pounds	1	1	2

The aim has been under both conditions to feed rations having the following nutritive ratios: With pigs weighing from 20 to 70 pounds, 1:2.8 to 1:3; with those weighing from 70 to 130 pounds, 1:3.6 to 1:4; and with those weighing from 130 to 200 pounds, 1:4.5 to 1:5.

From May, 1884, to September, 1889, ten separate experiments were made, in which 57 pigs were used. The average results of each of these experiments are given in the following summary, which is taken from the report. The pecuniary results are calculated on the basis of corn meal at $24, barley meal at $30, corn-and-cob meal at $20.70, and wheat bran and gluten meal each at $22.50 per ton; buttermilk at 1.37 cents, and skim milk at 1.8 cents per gallon; and by deducting 70 per cent of the estimated value of the fertilizing ingredients of the food to determine the net cost.

Results of ten feeding experiments with pigs (1884-89).

Experiment.	Number of pigs.	Average weight of pigs at beginning of experiment.	Average weight of pigs at close of experiment.	Articles of fodder used.	Total cost of food per pound of dressed pork.	Net cost of food per pound of dressed pork.
		Pounds.	*Pounds.*		*Cents.*	*Cents.*
I. May 21 to Sept. 23, 1884. a	3	48.8	239.0	Skim milk, corn meal	5.15	3.45
b	3	47.6	253.9	Buttermilk, corn meal	4.30	2.92
II. Nov. 5, 1884, to Mar. 21, 1885. a	6	30.1	209.7	......do	5.91	4.11
b	6	28.7	227.0	Skim milk, corn meal	5.51	3.82
III. April to Sept. 16, 1885	2	49.8	279.3	Skim milk, corn meal; Wheat bran, gluten meal	6.41	4.40
IV. Dec. 8, 1885, to May 31, 1886.	2	32.9	152.4	Skim milk, corn meal; Wheat bran, gluten meal	6.33	4.20
V. Sept. 15, 1886, to Jan. 19, 1887.	4	32.6	175.0	Skim milk, corn meal; Wheat bran, gluten meal	5.40	3.38
VI. Feb. 17 to May 2, 1887	5	54.4	152.8	Skim milk, corn meal; Wheat bran, gluten meal	5.69	3.74
VII. June 28 to Oct. 26, 1887	7	24.5	193.3	Skim milk, corn meal; Wheat bran, gluten meal	5.15	3.39
VIII. Nov. 8, 1887, to Mar. 12, 1888.	6	25.2	186.4	Skim milk, corn meal; Wheat bran, gluten meal; Corn and cob meal	5.32	3.58
IX. Apr. 12 to Aug. 8, 1888	6	19.6	194.7	Skim milk, corn meal; Wheat bran, gluten meal; Corn-and cob meal	4.89	3.27
X. Apr. 26 to Aug. 28, 1889.	7	20.3	189.9	Skim milk, barley meal; Wheat bran, gluten meal	6.07	4.32

The conclusions drawn from these experiments are the same as those stated in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 578).

Eleventh feeding experiment with pigs (pp. 95-105).—This experiment was made with five Yorkshire sows, weighing from 18½ to 21 pounds each at the beginning of the trial, and lasted from September 10, 1889, to March 3, 1890—175 days. The pigs were all fed alike. Each animal received daily 5 quarts of skim milk, except during the first 10 days of the trial, when only 4 quarts were given. The grain added to this milk was as follows: September 10 to 30, 2 ounces of corn meal per quart of milk; October 1 to November 11, 6 ounces of a mixture of 1 part by weight of wheat bran and 2 parts of gluten meal, which was increased with the increasing weight of the pig to from 30 to 36 ounces at the close of the period, when the pigs weighed from 85 to 95 pounds each; November 12 to December 30 a mixture of 4 parts by weight of corn meal and 1 each of wheat bran and gluten meal, of which 32 to 36 ounces per pig were given daily at the beginning of the period, and 42 to 45 ounces at the close, at which time the pigs averaged about 130 pounds each; and December 31 to March 3, a less nitrogenous mixture, composed of 6 parts by weight of corn meal, and 1 each of wheat bran and gluten meal, of which about 48 ounces per day were fed toward the close of the trial.

The nutritive ratio of the rations was thus, with a live weight of 20 to 90 pounds (September 10 to November 11), 1:3; with a live weight of 90 to 130 pounds (November 11 to December 30), 1:3.8; and with a

live weight of 130 to about 200 pounds (December 30 to March 3), 1:4.25.

Full tabulated data are given for each pig, together with analyses of the skim milk and gluten meal, and the fertilizing ingredients of the corn meal, wheat bran, gluten meal, and skim milk which were fed. A summary of the results follows:

Results of eleventh feeding experiment with pigs.

	Total cost of food consumed.	Live weight gained during experiment.	Dressed weight gained during experiment.	Cost of food per pound of dressed weight.	Net cost of food per pound of dressed pork.*
		Pounds.	*Pounds.*	*Cents.*	*Cents.*
Pig No. 1	\$7.58	167.00	138.50	5.47	3.49
Pig No. 2	8.02	178.25	147.75	5.43	3.45
Pig No. 3	8.19	174.75	146.75	5.58	3.60
Pig No. 4	7.69	162.75	134.50	5.72	3.74
Pig No. 5	7.54	160.75	135.25	5.57	3.59

* Total cost of food less 70 per cent of the estimated value of the fertilizing ingredients.

The average net cost of food per pound of dressed pork was 3.57 cents. The pecuniary results are based on corn meal at \$19, wheat bran at \$16.50, and gluten meal at \$23 per ton, and skim milk at 1.8 cents per gallon.

Twelfth feeding experiment with pigs (pp. 106–112).—Eight pigs, four Yorkshires and four grade Chester Whites, were fed from April 22 to September 1, 1890, practically the same rations as those in the preceding experiment, except that corn-and-cob meal was fed in place of the corn meal. The details are tabulated in full, together with analyses of the corn-and-cob meal fed, and the fertilizing ingredients in the corn-and-cob meal, wheat bran, gluten meal, and skim milk.

The four Yorkshires gained 473.04 pounds of dressed weight at a cost per pound of 3.61 cents, and the four grade Chester Whites 484.62 pounds of dressed weight at a cost per pound of 3.49 cents.

FODDER ANALYSES, C. A. GOESSMANN, PH. D. (pp. 113–134).—Analyses made during the year 1890 are given of the following feeding stuffs: Corn meal, corn-and-cob meal, wheat bran, wheat shorts, wheat middlings, buckwheat middlings, old and new-process linseed meal, cottonseed meal, gluten meal, seed of Scotch tares, corn fodder, corn stover, corn silage, soja bean and cowpea silage, vetch and oats, Royal English Horse and Cattle Condiment, and Harvey's Universal Vegetable Food; the fertilizing ingredients of old and new-process linseed meal, cottonseed meal, gluten meal, corn fodder, soja bean and cowpea silage, vetch and oats, and seed of Scotch tares. There is also a description of the methods employed in the analysis of feeding stuffs.

FIELD EXPERIMENTS, C. A. GOESSMANN, PH. D. (pp. 135–199).

Some suggestions on the economical improvement of farm lands (pp. 135–148).—A reprint from Bulletin No. 36 of the station (see Experiment Station Record, vol. II, p. 56).

Effect of different forms of nitrogenous fertilizers on oats (pp. 149–158).—Eleven tenth-acre plats, the history of which was well known, each received a quantity of muriate of potash or potash-magnesia sulphate furnishing 12 to 13 pounds of potassium oxide, and of dissolved boneblack furnishing 8.5 pounds available phosphoric acid. In addition to this from 4 to 5 pounds of nitrogen as nitrate of soda or sulphate of ammonia, or 5 to 6 pounds as dried blood were applied on seven plats, the remaining four plats receiving no nitrogen. One plat received barnyard manure, potash-magnesia sulphate, and dissolved boneblack, furnishing approximately the same amounts of nitrogen, phosphoric acid, and potash as the other plats received. The fertilizer applied to each plat was the same in kind and amount as that applied for corn the preceding year.

The oats (Pringle Progress) were sown in rows 2 feet apart, each plat containing sixteen rows. Quite marked differences were noticed in the color of the plants on the different plats. "Upon plats which had received their nitrogen in the form of sulphate of ammonia, as well as upon those which had received no nitrogen-containing manurial matter, a light green tint of the foliage was noticed in the earlier stages of the growth of the oats. In the latter case this light green color remained until the maturing began; in the former case (sulphate of ammonia) the color became a deeper green as the season progressed." The crop was harvested August 11. The yields of grain and straw and the dry matter and fertilizing ingredients in the grain from each plat are tabulated. Excluding one plat, which was a failure, the yield of grain was smallest on the three plats receiving no nitrogen. "The plats containing potash-magnesia sulphate as the potash source yielded the largest amount of grain; each of these plats received its nitrogen supply in a different form—ammonium sulphate, blood, and nitrate of soda. * * * In the majority of cases where muriate of potash has furnished the potash the maturing of the crop was somewhat later than where sulphate of potash was used."

Influence of fertilizers on the quantity and quality of prominent fodder crops (pp. 159–168).—A report of progress on an experiment begun in 1884. Previous accounts may be found in the annual reports of the station (see Experiment Station Bulletin No. 2, part I, p. 86, and Experiment Station Record, vol. II, p. 580). In 1890 all the plats used in this experiment were fertilized with 600 pounds of ground bone and 200 pounds of muriate of potash per acre. Notes are given on the growth and yield of Kentucky blue grass (*Poa pratensis*), redtop (*Agrostis vulgaris*), Bokhara clover (*Melilotus alba*), sainfoin (*Onobrychis sativa*), Rhode Island bent grass (*Agrostis alba*), meadow fescue (*Festuca pratensis*), and herd's grass (*Phleum pratense*), and of mixtures of redtop with herd's grass and meadow fescue with herd's grass. Analyses with reference to both the food and fertilizing constituents are reported for meadow fescue, Kentucky blue grass, alsike clover, medium clover, sweet clover, and sainfoin grown in 1889 and 1890.

Experiments with field and garden crops (pp. 169–186, plates 2).—These were in continuation of experiments reported in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 580). Notes are given on the growth and yield of barley, perennial rye grass (*Lolium perenne*), Early Southern White corn, horse bean (*Vicia faba*), soja beans (*Soja hispida*), Scotch tares, common vetch (*Vicia sativa*), white lupine (*Lupinus alba*), serradella (*Ornithopus sativus*), Bokhara clover, (*Melilotus alba*) sainfoin (*Onobrychis sativa*), sulla (*Hedysarum coronaria*), *Lotus villosus*, sugar beets, flax, and Danvers carrots.

Analyses with reference to both the food and fertilizing constituents are reported for *Lotus villosus*, sulla, teosinte, Japanese buckwheat, small peas (*Lathyrus sativus*), Scotch tares, carrots, parsnips, barley straw, Bokhara clover, soja beans, and turnips. Analyses of samples of five varieties of sugar beets grown on the station grounds gave percentages of sugar in the juice ranging from 12.75 to 14.30.

Effects of phosphoric acid from different sources on potatoes (pp. 187–191).—The object of this experiment was to test the relative effects of like money values of phosphatic slag, Mona Island guano, apatite, South Carolina phosphate (floats), and dissolved boneblack for potatoes. The land used (a fair sandy loam) had been prepared for the experiment by cropping for the 3 previous years with corn, Hungarian grass, and leguminous crops, respectively, without applying fertilizers. It contained five plats, approximately one seventh of an acre each, separated from each other by strips 8 feet wide. All the plats received the same amount of potash-magnesia sulphate and nitrate of soda. The source of phosphoric acid was different on each plat, an amount being applied in each case which at the local market prices cost $6.25 per acre. Thus phosphatic slag, Mona Island guano, and South Carolina rock were each applied at the rate of 850 pounds per acre, dissolved boneblack at the rate of 500 pounds, and apatite at the rate of 2,000 pounds. Beauty of Hebron potatoes were planted on all the plats, in rows 3¼ feet apart, with the hills 18 inches apart in the rows.

Maturity seemed to have been hastened by a drouth occurring in July. The potatoes were harvested August 12–14, and assorted into marketable (sold at 60 cents per bushel) and small (sold at 20 cents). The yield and financial statement for each plat and analyses of the phosphates used are tabulated. A statement of the yield and value per acre follows:

Yield and value of potatoes per acre.

Source of phosphoric acid.	Yield of— Large potatoes.	Yield of— Small potatoes.	Total value of crop.
	Bushels.	*Bushels.*	
Phosphatic slag	134.6	43.0	$80.36
Mona Island guano	101.2	55.3	71.78
Ground apatite	117.1	47.1	79.68
South Carolina phosphate	149.8	48.7	99.82
Dissolved boneblack	170.3	56.8	113.54

"The dryness of the season renders the advantages of a soluble form of phosphoric acid very striking. The experiment will be repeated during the coming season."

Experiments with grass land (pp. 192–198).—An account is given of the improvement of a low, springy meadow by underdraining and seeding down with grass mixtures, and a report of the subsequent manuring of the land and the yields of hay from portions receiving different treatment in 1889 and 1890.

From "an unsightly, swampy meadow, covered with a comparatively worthless vegetation," the land has been brought up in 4 or 5 years to a yield of from 3 to 4¾ tons of good hay per acre.

General farm work (p. 199).—Remarks regarding the current farm work. "A new orchard, covering an area of from 6 to 7 acres, has been in part planted with apple, pear, peach, and plum trees; other varieties, as well as small fruits, will be planted during the coming spring."

REPORT OF VEGETABLE PATHOLOGIST, J. E. HUMPHREY, B. S. (pp. 200–226, plates 2).—This includes notes on the black knot of the plum, cucumber mildew, brown rot of stone fruits, potato scab, and various other plant diseases.

Black knot of the plum (pp. 200–210).—Brief account of the history of investigations of black knot of the plum (*Plowrightia morbosa*), and preliminary notes on observations by the author on the spore forms of this disease. A pycnidial form not previously observed is described and illustrated. Of the four kinds of spore fruits described by Dr. Farlow, the author has observed those producing ascospores and what seem to be second forms of pycnidia. The spermogonia and stylospores (*Hendersonula morbosa*, Sacc.) have not been found as yet.

Cucumber mildew (210–212).—The form of cucumber mildew first observed in this country in 1889, and hitherto known as *Peronospora cubensis*, was found on cucumbers and squashes in Massachusetts in 1890. This species and *P. australis*, found on the wild star cucumber, are compared and illustrated. The haustoria of both species are of the small, knoblike type. Those of *P. cubensis* are scattered over the yellow and dead-looking spots on the leaf and "do not form a close felt, visible to the naked eye." *P. australis*, on the contrary, forms dense white tufts, of small extent, on the leaves of the star cucumber. The structure of the spore-bearing threads in the two species is strikingly different.

Correlated with the development of small haustoria is frequently found, as in the grapevine mildew and in *P. australis*, a pinnate branching of the conidial threads, and conidia with an apical papilla, which germinate by producing zoöspores instead of a tube. In *P. cubensis* we have the anomaly of conidial threads which follow the type of branching usually seen in the species with branched haustoria, and conidia of a violet tint, such as are almost unknown except among the latter group, while the haustoria are small and the conidia have the apical papilla and produce zoöspores on germination. This species goes far to break down the distinctions held by some writers to exist between the two groups which constitute the genera *Plasmopara* and

Peronospora of recent writers, though all were formerly included in *Peronospora*. If the distinction is to be maintained on the basis of the germination of the conidia, we must then call these two fungi *Plasmopara australis*, Speg., and *Plasmopara cubensis*, B. and C. The formation of resting spores has not been observed in either species, yet it is evident that they have some means of surviving the winter.

Brown rot of stone fruits (pp. 213–216).—Observations by the author are cited which indicate that *Monilia fructigena* survives the winter through the formation of resting cells or gemmæ, and that, "whatever its origin, any other forms once connected with it have been lost, and it is therefore fairly safe to regard it as an autonomous fungus."

Potato scab (pp. 216–220).—Experiments along the lines suggested by those recorded in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 580) were continued in 1890. Of 13 varieties of potatoes tested in 1890 Rough Diamond was the only one which showed no scab, though Rural New Yorker and White Seedling were comparatively free from it. The plowing in of winter rye on half of each plat produced no perceptible effect on the amount of scab. The results from deep *vs.* shallow planting in 1890 do not bear out the opinion doubtfully expressed in 1889, that deep planting diminishes scab. The free use of coal ashes in the drill produced no observable effect on the development of scab. "The thicker-skinned and red-skinned varieties showed no greater resistance to scab than others; our best results in 1890 were from light-skinned and rather delicate fine-grained sorts." The results of investigations into the cause of scab by H. L. Bolley (see *Agricultural Science*, September and October, 1890) and by R. Thaxter, as given in Bulletin No. 105 of the Connecticut State Station (see Experiment Station Record, vol. II, p. 490), are briefly discussed. The author finds it difficult to believe that the "deep" and "surface" forms of scab are entirely distinct.

Miscellaneous notes (pp. 220–226).—(1) *Damping off of cucumbers.*—Observations by the author indicated that this affection is caused by the fungus *Pythium de baryanum*, Hesse, which is known to produce the same effect in Europe. On the assumption that this fungus is always the cause of the trouble, "plants affected should be at once removed, with the soil immediately surrounding them, and burned. If this is done as soon as the seedling falls, the trouble can be held in check, since the fungus will be destroyed before its reproductive organs have developed."

(2) Brief notes are also given on the mildew of spinach (*Peronospora effusa*), grapevine mildew (*Plasmopara viticola*) observed on *Ampelopsis veitchii*, downy mildew (*Peronospora parasitica*) and white rust (*Cystopus candidus*) on turnips, potato rot (*Phytophthora infestans*), elder rust (*Æcidium sambuci*), rust of blackberries and raspberries (*Cæoma nitens*), hollyhock rust (*Puccinia malvacearum*), and an undetermined disease of oats.

SPECIAL WORK IN CHEMICAL LABORATORY (pp. 227–312).—This includes the work done by the station during the year in the inspection of commercial fertilizers, analyses of wood ashes, cotton-hull ashes,

saltpeter waste, refuse from glue factory, fish chum, dry ground fish, blood, bone and meat, ground bone, bones boiled in potash, starch waste, "sludge" from Worcester sewage-precipitating tanks, tankage, Florida phosphate rock, dissolved boneblack, German phosphatic slag, hen manure, jute waste, shelled corn, buckwheat hulls, seaweed, residuum from soft coal, vegetable ivory, Concentrated Flower Food, Flora Vita, compound fertilizers, Paris green, Sulphatine, Death to Rose Bugs, Professor De Graff's Bug Destroyer, tobacco liquid, and 65 samples of well water, and a compilation of analyses of agricultural chemicals and refuse materials used for fertilizing purposes, feeding stuffs, fruits, sugar-producing plants, dairy products, etc.

Commercial fertilizers (pp. 228–258).—General remarks on commercial fertilizers and their inspection, the trade values of fertilizing ingredients for 1890, the text of the Massachusetts fertilizer law, list of licensed dealers, and analyses of 158 commercial fertilizers, including bones, sulphate of ammonia, sulphate of potash, muriate of potash, and nitrate of soda. Of the 158 samples analyzed, 54 were below the guaranty in one ingredient, 10 in two ingredients, and 3 in all three ingredients; 56 were above the guaranty in one ingredient, 30 in two ingredients, and 4 in all three ingredients. "The deficiency in regard to one or two essential constituents was in the majority of cases commercially compensated by the excess of another one."

METEOROLOGY (pp. 313–316).—Brief notes on the weather and a summary of meteorological observations for each month of 1890.

REPORT OF TREASURER, F. E. PAIGE (p. 317).—This is for the year ending December 31, 1890, and contains a summary of the property of the station, in addition to a statement of receipts and expenditures.

Massachusetts State Station, Bulletin No. 40, July, 1891 (pp. 16).

METEOROLOGICAL SUMMARY (p. 1).—This is for the months of March to June, 1891, inclusive.

SOME DISEASES OF LETTUCE AND CUCUMBERS, J. E. HUMPHREY, B. S. (pp. 2, 3).—A brief announcement of observations on a species of *Botrytis* or *Polyactis* as the cause of lettuce rot, and on the powdery mildew of the cucumber (*Oidium erysiphoides*, Fries, var. *cucurbitarum*). Details will be published in the Annual Report of the station for 1891.

FERTILIZERS, C. A. GOESSMANN, PH. D. (pp. 4–6).—Analyses of 16 samples of commercial fertilizers and 5 samples of bone, and the trade values of fertilizing ingredients for 1891.

FEEDING EXPERIMENTS WITH STEERS, C. A. GOESSMANN, PH. D. (pp. 7–16).—"With a view to determining the cost of the food required for the production of beef under existing local conditions," an experiment, the first of a series, was made during the winter of 1889–90 with two yearling and two 2-year-old grade Shorthorn steers. Two different ages were taken to observe the difference in the cost of the gain as the

animals grew older. The steers were all fed definite quantities of the grain rations, consisting at different times of wheat bran, with gluten meal or old-process linseed meal, or with linseed meal and corn-and-cob meal, and coarse fodders consisting of corn stover, corn silage, corn fodder, or stover and sugar beets, *ad libitum*. The only essential difference between the food of the older and younger animals was in regard to the quantity and proportion of the constituents of the grain rations. The yearlings were fed from December 17, 1889, to May 9, 1890 (20 weeks) and the 2-year-olds from December 10, 1889, to March 25, 1890 (15 weeks). Full tabulated data with reference to food consumed, gain in live weight, cost of rations, cost of food per pound of gain, etc., are given for each animal, together with the fertilizing ingredients in each of the feeding stuffs used. In estimating the cost of food, wheat bran and corn-and-cob meal are each reckoned at $16.50; gluten meal at $23; old-process linseed meal at $27.50; corn stover and sugar beets each at $5; corn fodder at $7.50, and silage at $2.75 per ton, allowing 8 per cent for the loss of fertilizing ingredients of the food. "The net cost of the food, therefore, represents the cost of the food consumed after deducting from its original market price 92 per cent of the money value of the essential fertilizing constituents—nitrogen, phosphoric acid, and potassium oxide—it contains."

A tabulated summary of the results for the whole experiment follows:

Summary of results of feeding steers.

	Live weight at beginning of experiment.	Gain in live weight.	Dry matter consumed per pound of gain.	Total cost of food consumed.	Total value of fertilizing ingredients in food.	Net cost of food per pound of gain.*
	Pounds.	*Pounds.*	*Pounds.*			*Cents.*
Yearlings: No. 1	675	220	8.91	$16.92	$11.35	2.95
No. 2	600	210	8.78	17.52	11.82	2.77
2-year-olds: No. 3	1,235	135	17.19	16.37	11.26	4.45
No. 4	1,180	120	17.32	15.31	10.40	4.78

*Allowing a loss of 8 per cent of the manurial value of the food.

Corn silage, when fed either with wheat bran and gluten meal or with wheat bran and old-process linseed meal, produced the highest gain in live weight without exception. The increase in live weight when feeding the silage ration to 1-year-old steers, in one instance, exceeded 3 pounds per day; while in the case of 2-year-old steers it averaged more than 4 pounds per day in one case.

The original cost of the food consumed per day on the silage ration was from 12.82 to 14.72 cents in the case of 1-year-old steers, and from 16.67 to 19.33 cents in the case of 2-year-old steers; and the net cost of the food per day was from 4.81 to 5.26 cents in the case of 1-year-old steers, and from 6.65 to 7.44 cents in the case of 2-year-old steers.

While on the silage ration the daily increase in live weight averaged 2.9 pounds for the yearlings and 3.45 for the 2-year-olds. The first cost of the food during this time averaged 4.8 cents per pound of gain for the younger animals and 5.22 cents for the older, while the net cost averaged 1.82 cents for the yearlings and 2.08 cents for the 2-year-olds.

The two yearlings were pastured from May 10 until September 30 at a cost of 40 cents each per week. Steer No. 1 gained 125 pounds and No. 2, 83 pounds in live weight, at which rate the cost per pound of gain would be 6.58 cents for No. 1 and 9.91 cents for No. 2.

Massachusetts Hatch Station, Bulletin No. 14, May, 1891 (pp. 62).

SOIL TESTS WITH FERTILIZERS, W. P. BROOKS, B. S.—A report of 13 coöperative experiments with corn made in 1890 in ten different counties of the State. As in the experiments of 1889, reported in Bulletin No. 9 of the station (see Experiment Station Record, vol. II, p. 233), the plan followed was that adopted by the conference of experiment station representatives at Washington in March, 1891, and published in Circular No. 7 of this Office.

Fifteen twentieth-acre plats were used in each of the experiments except one. These plats were separated by intervening strips, making the total area 1 acre. The soils represented were mostly loams, ranging from light sandy to clayey loam. As indicated by the yields of the unfertilized plats, they were in general quite even in fertility, being in this respect better adapted for experimenting than many of those used in 1889. Nitrate of soda at the rate of 160 pounds per acre, dissolved boneblack at the rate of 320 pounds, and muriate of potash at the rate of 160 pounds were used singly, two by two, and all three together on seven plats; land plaster 160 pounds, lime 160 pounds, and barnyard manure 5 cords per acre were each used on one plat, and 5 plats received no application. The analyses of these materials are given. The fertilizing materials were in all cases applied broadcast upon the plowed land and harrowed in just before planting. The corn was planted in rows 3½ feet apart, and, with one or two exceptions, in hills. The selection of the variety was left to the individual experimenter, but in most cases a yellow flint variety was used. The fertilizers, except the barnyard manure, were supplied by the station. Each experimenter was also furnished with maximum and minimum registering thermometers and a rain gauge. In nearly every case the work was carried out according to the directions given.

Each experiment was inspected twice during the season by representatives from the station, and the harvesting and weighing of the crops were done in the presence of an assistant.

Each of the thirteen experiments, including two made at the station, is reported by itself, and details are given in each case with reference to the fertilizers applied; the yield of corn and stover per acre; the gain or loss compared with the unfertilized plats; the result of measurements made during the growing season; the calculated results of the addition of nitrogen, phosphoric acid, potash, complete fertilizer, barnyard manure, land plaster, and lime; the financial results; summary of the weather observations; and analyses of the barnyard manure used. In

several instances the same land was used as in 1889, and in these cases the results of 1890 often strengthened the conclusions reached in the preceding year.

The results of each experiment are discussed at considerable length and in most cases practical suggestions are made as to the treatment of the soil likely to give the most profitable results. The following are among the author's conclusions from the experiments:

(1) Our results show that soils differ widely in their requirements.

(2) Potash, however, much more often proves beneficial or proves much more largely beneficial than either nitrogen or phosphoric acid.

(3) Potash as a rule most largely increases the yield of both grain and stover, but its effect upon stover production is greater than upon grain production.

(4) Barnyard manures are as a rule relatively deficient in potash, probably because of the loss of a large proportion of the urine, which contains about four fifths of the total potash of the excretions. * * *

(5) The relative deficiency of potash in so many soils, shown now by the results of the work of two seasons, I believe justifies the following general advice:

In breaking up sod lands for corn, particularly that which is in fair condition but which has been under ordinary farm management, if fertilizers only are to be used apply those which are rich in potash. Use materials which will supply 80 to 100 pounds of actual potash, from 25 to 30 pounds of phosphoric acid, and from 15 to 20 pounds of nitrogen per acre.

If a special corn fertilizer is to be used, apply only a moderate quantity, say 400 to 500 pounds per acre, and use with it about 125 pounds of muriate of potash. It is believed this combination will produce as good a crop as 800 to 1,000 pounds of "corn fertilizer," and it will cost considerably less.

With ordinary barnyard or stable manure for corn use potash. I would recommend using about 4 cords of manure and 100 pounds of muriate of potash per acre.

For fodder or silage corn use, either in fertilizers or with manures, about one fourth more potash than above recommended.

In our experiments all fertilizers and manures have been applied broadcast and harrowed in, and I believe this is the best method.

Formulas based on the results of these experiments are given for five different fertilizing mixtures for corn.

Brief mention is made of an experiment at the station with fertilizers for potatoes, in which the arrangement of the plats and the kinds and quantities of fertilizers used were the same as in the corn experiment described above. The detailed records of this experiment were destroyed by fire, but the author states that "no plat gave an entirely satisfactory crop. The barnyard manure gave the largest yield, but not of the best quality. Quantity and quality considered, the complete fertilizer gave the most satisfactory results, but not the most profitable. Potash for this crop, as for corn, seemed to be most deficient in this soil."

Massachusetts Hatch Station, Meteorological Bulletin No. 31, July, 1891 (pp. 4).

A daily and monthly summary of observations for July at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Mississippi Station, Bulletin No. 15, June, 1891 (pp. 16).

FEEDING, E. R. LLOYD, M. S. (pp. 2-4).—*Feeding experiments with milch cows.*—"To determine the relative values of different foods for the production of milk and butter" six lots of 5 cows each (4 grade Jerseys and 1 grade Holstein) were fed the following rations per animal daily during 5 weeks, the first week being regarded as preliminary:

Lot 1, 9.2 pounds Bermuda hay + 9.5 pounds raw cotton seed.
Lot 2, 10.5 pounds Bermuda hay + 10.6 pounds roasted cotton seed.
Lot 3, 8.5 pounds Bermuda hay + 10.4 pounds steamed cotton seed.
Lot 4, 9.9 pounds Bermuda hay + 9.9 pounds corn meal.
Lot 5, 8.5 pounds timothy hay + 9.5 pounds raw cotton seed.
Lot 6, 10.9 pounds Bermuda hay + 9.5 pounds cotton-seed meal.

"The cows in the different lots averaged as nearly as possible the same length of time from calving, and the yield of each lot did not vary more than 2 pounds from any other lot." The milk of each cow was weighed separately, and tests of the fat contained in the mixed milk of each lot were made morning and evening by the Babcock and Beimling methods. The tabulated data given include for each lot the gain in live weight, the production of milk and of butter fat (as calculated from the analyses of the milk), and the cost of the same. The financial results are based on timothy hay at $20.80, Bermuda hay at $12.50, raw cotton seed at $6, roasted cotton seed at $7.20, steamed cotton seed at $6.30, cotton-seed meal at $20, and corn meal at $25 per ton, making no allowance for the value of the manure.

According to the results as tabulated, lot 1, receiving Bermuda hay and raw cotton seed, produced butter and milk at the lowest cost.

This lot produced milk at a cost of 7.7 cents per gallon and butter at a cost of 17.4 cents per pound, but the butter was of poor quality, being sticky and of poor flavor. The most expensive milk and butter were from lot 4, which was fed on Bermuda hay and corn meal, the milk costing 12.8 cents per gallon and the butter 41.4 cents per pound. [This ration cost more than twice as much as that given lots 1 and 3, and was by far the most expensive ration fed.] The butter from this lot was of excellent quality, but not so good as that from lot 3, and cost more than twice as much. This lot also showed a loss of flesh of 34 pounds, while lot 3 gained 214 pounds.

As between Bermuda hay and timothy hay (lots 1 and 5) the results were in favor of the former. Lot 5 (timothy) "gained well in flesh, but produced only a small amount of milk." Based on the gross cost of the food, the milk produced by this lot cost 12.8 cents per gallon, and the butter 29.5 cents per pound, as compared with 7.7 cents and 17.4 cents where Bermuda hay and cotton seed were fed (lot 1). "Had the timothy cost the same as did the Bermuda hay, the cost would have been only 9.5 cents per gallon for the milk and 21.9 cents for the butter."

The author believes from the work done at the station up to the present time that in that section—

(1) For the production of milk a ration consisting of Lespedeza hay and raw cotton seed is the cheapest.

(2) For the production of butter a ration of Lespedeza or Bermuda hay and steamed cotton seed is the most profitable.

(3) When fed cotton seed, either raw, roasted, or steamed, cows will gain in flesh better than when fed corn meal or cotton-seed meal.

(4) Either Bermuda or Lespedeza hay is preferable to timothy hay.

(5) Corn meal is not an economical grain ration when fed with dry hay.

(6) Steamed [cotton] seed will produce better butter than will either raw or roasted seed.

Hay for working mules (p. 4).—An experiment in which three working mules were fed Bermuda hay and three others timothy hay *ad libitum* for 2 months, both lots receiving the same amount of corn, showed "practically no difference between the two rations."

COMPARATIVE TESTS OF MACHINES AND METHODS FOR THE DETERMINATION OF FAT IN MILK, L. G. PATTERSON (pp. 5–16, figs. 7).—A description is given of the Patrick brine-bath method, and the Babcock and Beimling centrifugal methods for determining the fat in milk, together with the results of comparative determinations by each of these methods and the Adams gravimetric method. Five tests by the Babcock method were spoiled by the belt becoming too loose. Of the 29 remaining tests by this method, the results of 9 differed from the gravimetric by 0.1 per cent or less, 8 by 0.2 per cent or over, and 2 by over 0.33 per cent, the largest difference being 0.38 per cent. Of 34 tests by the Beimling method 18 gave results differing from the gravimetric by 0.1 per cent or less, 4 by 0.2 per cent or over, and the greatest difference was 0.24 per cent. Twelve of the 17 tests made by the Patrick method differed from the gravimetric by 0.1 per cent or less, 2 by over 0.2 per cent, and the greatest difference was 0.27 per cent. The following are the author's conclusions:

The Beimling method requires less time than does either of the others, but the scale on the bottles is not as easy to read and no means are provided for keeping the fat in a melted condition.

The Babcock has the best bottles, but requires more time for its operation, and it is absolutely necessary to have the specific gravity of the acid exactly 1.82.

The Patrick method is very convenient where a large number of tests are to be made, but it requires considerable time to heat the bath, and the bottles are very easily broken.

Missouri Station, Bulletin No. 15, July, 1891 (pp. 16).

TEST OF VARIETIES OF WHEAT AND OATS, H. J. WATERS (pp. 3–11).—Tabulated data are given for 13 varieties of wheat tested in 1889 and 55 in 1891, and for 11 of oats in 1889 and 13 in 1891.

In the test of varieties of wheat in 1889, Fultz led in yield and gave the smallest number of pounds of straw per bushel of grain; while in point of yield Red Chaff was second and Hybrid Mediterranean third. In 1891 the order was changed, giving Extra Early Oakley the lead with a yield of 42.5 bushels, while Willits followed with a yield of 39 bushels, and Coryell third, giving a crop of 36.9 bushels. In 1889

the main wheat crop, Fultz, in the same field with the varieties, gave a yield of over 35 bushels per acre, and in 1891 the remainder of the field where the varieties were grown yielded slightly over 30 bushels. From this it will be seen that our determination of yield per acre for a small area is not wide of the truth. There appears to be no direct relation between the proportion of straw down at harvest and the yield. Fultz gave a good though not the best yield. A further trial of the varieties leading in yield in 1891 will be necessary before their general adoption will be advisable.

In the comparative test of varieties of oats Pringle Progress gave the largest yield in both 1889 and 1891, though in weight per measured bushel it was among the lowest.

CHANGE OF SEED OF WHEAT, OATS, AND POTATOES, H. J. WATERS (pp. 11–16).—Descriptive notes and tabulated data for an experiment planned with reference to comparing the results of planting Northern and Southern-grown seed.

New Jersey Stations, Bulletin No. 81, July 1, 1891 (pp. 15).

INCOMPLETE FERTILIZERS AND HOME MIXTURES, E. B. VOORHEES, M. A.—Analyses are given of sixty-three samples of fertilizing materials, including nitrate of soda, sulphate of ammonia, dried blood, boneblack, bone ash, rock phosphates, muriate of potash, sulphate of potash, double sulphate of potash and magnesia, kainit, and home mixtures; the schedule of trade values adopted for 1891 by the New Jersey, Connecticut, and Massachusetts Stations; a table comparing the average cost of essential ingredients at the retail prices of the raw materials, with the station schedule; and formulas for home mixtures for general crops, for potatoes, and for peach trees. The comparison of the cost per pound of nitrogen, phosphoric acid, and potash at the prevailing retail prices of raw materials with the schedule of trade values adopted for 1891 revealed the fact that "the station's schedule agrees closely with the manufacturers' averages for nitrogen and potash, while in the case of available phosphoric acid the station's prices are over 20 per cent greater than the prices at which it has been bought by farmers direct from the manufacturers."

The analyses of the home mixtures, which had been made according to formulas furnished, showed a very close agreement between the percentage of ingredients as calculated from the formulas and that actually found in the mixtures.

The main objects of the analyses were to determine, (1) whether farmers, using the ordinary tools and labor of the farm, could make even mixtures of the materials used; and (2) whether in the cost of actual plant food, home mixing presented any advantages over the usual method of buying manufactured fertilizers. * * * The mixtures do contain practically the amount and proportion of plant food that they were intended to furnish, and therefore show that farmers are able to make even mixtures of such raw materials as the market affords.

[Concerning the pecuniary results] the station's valuation of the home mixtures is $2.92 greater than their cost. This represents the total saving only when the station's valuation of manufactured brands is equal to their selling price at the point of consumption.

New Jersey Stations, Bulletin No. 82, July 3, 1891 (pp. 40).

THE ROSE CHAFER, J. B. SMITH (figs. 10).—This is a popular account of observations and experiments by the author and his correspondents on the rose chafer (*Macrodactylus subspinosus*) during 1890 and 1891. Reference is made to earlier accounts of this insect by Harris and Fitch, and especially to an article by Riley published in Insect Life, vol. II, p. 295, from which two of the ten figures illustrating the bulletin are taken. The subjects treated are, history of the insect in New Jersey, food habits, mouth parts, habits of the beetle, date of appearance, egg-laying habits, the larva, breeding habits, life history, and remedies.

This insect has done more injury during the past few years than any one other species in the State of New Jersey, excepting perhaps the codling moth and plum curculio. * * * From all that I can learn, the present invasion dates back some 4 to 6 years, and has been gradually extending and increasing since that time, until the larger part of the grape-growing region of southern New Jersey is invaded. Rather more than 20 years ago there was a similar irruption, which lasted 4 or 5 years and then suddenly ceased. In the interval the species was common, as it is nearly all over the State, but did no injury that attracted general attention. * * *

It is a peculiar fact, for which I have no explanation, that some localities, often very small, are almost exempt, while all around suffer; and again, one spot may be totally destroyed and the other as completely exempt. One year a narrow road will limit their wanderings, another year sees as pread of many miles, unchecked by forests or streams. * * *

[Numerous kinds of plants are mentioned as serving for food for this insect.] Poppies were attractive and so was the foxglove—but those which ate of the latter ate no more. The plant is evidently poisonous to the beetle, as a circle of dead specimens around each indicated. There were few beetles on this plant, however, compared with those on more attractive food. This observation led to an experiment with digitalis, which was not as satisfactory as I had hoped.

[The mouth parts of the beetle are described and illustrated.]

The true mandibles are small, mostly soft, and only partly chitinized, but with a hard, rough space at the inner side of the base, which might be called a molar or grinder; above this is a piece furnished with a dense fringe of hair which looks as if it might serve as a brush, and outside of that we find a third piece bearing a little pointed blade at the tip, which we can term the piercer.

This might be considered sufficient for all practical purposes, but we find in addition a second pair of jaws, set at the side of the lower lip, and these are furnished with a broad, hardened, chitinous tip, set with six pointed teeth. The latter are, I believe, the instruments with which the food is cut, to be afterward ground between the molars of the mandibles.

The beetles are active only during the day and most active in bright sunshine, feeding most generally in the afternoon, when the day's flight is over. They are torpid at night and quiet in cold or wet weather, doing little or no feeding, and not moving about. In bright, warm weather they take long flights, and the air is full of moving insects. They then fly from their breeding grounds and seek favorable feeding places, lighting in swarms on attractive plants and remaining there if undisturbed. I am of the opinion that when a specimen once settles down on a food plant it does not leave it again until the food is exhausted, and this explains why vineyards are usually injured along the edges first. I have watched a marked pair feeding on the same rose 3 days in succession. In cold or wet weather the nearest food plant will be selected, and thus the spread from the breeding places is prevented in favorable seasons, such as that of 1891. * * *

[The date of appearance] varies somewhat with the season, and ranges in the Vineland region from May 19 to May 25; it does not differ much for the rest of south Jersey, though they are about a week or 10 days later in the New Brunswick region and farther north. * * *

During the season of 1890 I tried to get at the egg-laying habits of the species by watching the insects in the field; but though I made my examinations at all hours of the day, from sunrise to sunset, I never found them ovipositing, and got no definite results. Yet eggs were constantly decreasing in number, and in 1890 many that were examined June 13 had none remaining in the ovaries. * * *

In order to discover the mature egg and the egg-laying habits of the insects, a considerable number were collected, only those in copulation being taken, in order that the sexes should be equally represented. These were placed in a large jar filled to the depth of 5 inches with soil from the vineyards, in which the larvæ were found during the early part of the season. Plenty of food (roses) was added and the jar was set out doors to give as nearly natural conditions as was possible. Before night a considerable number began burrowing into the ground; sometimes the female only, sometimes male and female working together and keeping side by side. Some of the beetles went down about 3 inches only, others burrowed to the bottom of the jar. More than half of them made no effort to burrow at all and fed until evening. * * * About the middle of next day I removed all those on top of the ground and placed them in another jar, prepared in the same way and with fresh food. Next morning I found that nine specimens had made their way to the surface in jar No. 1, and others were noticed burrowing in jar No. 2. Those in jar No. 1 were acting in a dispirited manner, fed only in a half-hearted way, and about one half (females) were dead before night. These were examined and the ovaries were empty. Those still alive had not more than twelve eggs left in the ovaries—six in each.

Turned out the earth carefully and found several more beetles still under ground and making little effort to move. In these cases the ovaries of the females were empty or had only a very few immature eggs. The most careful search discovered only some six or eight eggs, although there must have been many in the jar. The difficulty was in the recognition of the difference between an egg and a coarse grain of sand. The egg is yellowish gray in color, oval, the skin quite tough and parchment-like, covered with dust, so that it was simply impossible to recognize it except by touch with a knife point. They are evidently laid singly and at depths of from 3 to 6 inches under ground. With the second jar my experience was the same as with the first. The insects that were still lively and ready to fly had all more than twelve eggs; but some of the others, which, though not lively, were still feeding, were entirely bare of eggs. It is probable, then, judging from this observation and from the observations made last year in the field, that at least two trips under ground for the purpose of ovipositing are made by the female, and that on each occasion she deposits not less than twelve eggs. How long an interval there is between journeys I can not say, but I watched one pair, recognizable by a coat of whitewash, for 3 days, during which time they had evidently not been under ground. It is also a question as to how long the insects will feed after emerging from the ground and before beginning to oviposit. Specimens taken from the ground May 25 showed the eggs in the ovaries very immature and scarcely more than separated in the tubes. Thirty-six, the normal number of eggs to each female, I found the rule from June 5 to 11. At that time, 2 weeks after their first appearance, egg laying was not yet general, but was beginning. A considerable number of holes under badly infested vines, more noticeable in the early morning, seemed to indicate burrows for egg-laying purposes. My experience in 1890, when I found many females with empty ovaries on June 14, indicates that egg laying probably begins about 10 to 14 days after the insects first emerge, and that 1 week at the utmost is the period required by a single female to get rid of her stock of eggs. In 1891, I found at Jamesburg, June 20, numerous specimens on ferns and bracken, some females with empty ovaries, some with twenty-four eggs. We may therefore assume rather less than 3 weeks as the normal period of life for a single insect, and as the

time of maturing the beetles extends over about 1 week, or at most 10 days, the normal 4 weeks of the rose-bug invasion is accounted for. The settlement of this question is not unimportant, for it shows that vigorous measures for the destruction of these pests, taken early in the season of their appearance, have a twofold advantage: They not only lessen or avert immediate injury, but they also prevent oviposition, and thus lessen the next season's brood.

[From observations in different localities the author concludes] that the whole of the sandy region of south Jersey is a vast breeding ground for the larvæ, that they are scattered everywhere—comparatively abundant in cultivated ground and in light meadow land, and rare in heavy or wet soil or in such as has a hard surface crust. * * * In such lands as are plowed and cultivated, or are dressed with potash salts or nitrate of soda, the larvæ will not mature. Cultivation is therefore one very important way of keeping these pests in check.

[The life history of the rose chafer is thus briefly stated:] The eggs are laid under ground, singly, from the 10th to the 25th of June or perhaps later. How long this state lasts we do not know, but probably from 12 to 20 days. The larva feeds on the roots of plants, preferably grass, in light soil, descends below frost line during winter, ascends early in spring, and in April or in early May changes to a pupa. This state lasts from 10 to 30 days according to weather, and then from May 19–27 the beetles begin to transform and emerge, about 3 weeks being the life of an individual insect.

In connection with the discussion of remedies to be used for this insect, the breathing apparatus is described and illustrated. Unsuccessful experiments are reported with London purple, copper mixtures, pyrethrum, kerosene emulsion, kerosene extract of pyrethrum, lime, tobacco, acetic acid, quassia, digitalis, corrosive sublimate, muriate of ammonia, cyanide of potassium, Odorless Bug Killer, sludgite or "zomonia," kainit, and alum. Experiments with hot water (125° F.) indicated that this is an effectual remedy, provided the practical difficulties in the way of the application of the water at the proper temperature can be overcome. The planting of *Spiræa* and of blackberries as a means of attracting the rose chafer from other plants the author thinks may be of advantage to a limited extent. His experience leads him to the conclusion "that mechanical means of destruction, supplemented by counter attractives, can be relied upon in ordinary seasons to protect vineyards from the rose chafer." Modifications of the ordinary collecting umbrellas are described and illustrated. The bagging of grapes to protect them from the rose chafer, as well as from rot, is recommended. No indications have been found that the rose chafer suffers from parasites.

The following are among the practical suggestions given in the bulletin:

Prevent the breeding of the insects on your own land. This can be done by using only the heaviest land for grass, and keeping just as little light land as possible in sod. As the insects pupate early in May a thorough cultivation of all the ground that can be cultivated will turn up and destroy a large proportion in this stage. Either late in fall or early in spring land should be plowed and top-dressed with kainit. Where light grass land is to be put into use, plowing at this time would be most effective in destroying the insects. Vineyards especially should be deeply and thoroughly cultivated in May to turn up and destroy pupæ. The cleaner the land is kept the fewer insects will come to maturity. A great point is gained if the enemy

must come from the outside and does not appear everywhere in the vineyard at one time. * * *

In setting out vineyards, make use of those varieties that bloom early or very late, and of the *labrusca* varieties select the earliest. Plant Clinton or other *riparia* varieties among the Concord or *labrusca*. * * *

Stimulate the vines by appropriate fertilizers to force the blossoms, and by inducing a heavy bloom get a surplus that will stand some thinning by insects without really shortening the desired crop.

While the danger is greatest a man should be sent through the vineyard at least twice a day (Sundays not excepted), say in the early morning and just after noon, to clear the vines of beetles, using one of the described collectors. * * *

Collecting should be continued at least once a day for 3 weeks (even if the insects do no further injury) to prevent egg laying.

North Carolina Station, Bulletin No. 75*c* (Meteorological Bulletins Nos. 17 and 18), April 28, 1891 (pp. 31).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, FEBRUARY AND MARCH, 1891, H. B. BATTLE, PH. D., and C. F. VON HERRMANN.—Notes on the weather, and monthly summaries and tabulated daily record of meteorological observations by the North Carolina weather service. The bulletin is illustrated with maps of North Carolina, showing the isothermal lines and the total precipitation for different parts of the State.

North Carolina Station, Bulletin No. 76, March, 1891 (pp. 20).

PLANT DISEASES AND HOW TO COMBAT THEM, G. MCCARTHY, B. S. (figs. 13).—Brief general statements regarding fungous diseases of plants, formulas for various fungicides, illustrated descriptions of spraying apparatus, and popular accounts of the following diseases, with suggestions as to remedies: Black rot of grapes (*Læstadia bidwellii*), mildew of the grape (*Peronospora viticola*), anthracnose of the grape (*Sphaceloma ampelinum*), black knot (*Plowrightia morbosa*), peach rot (*Monilia fructigena*), apple scab (*Fusicladium dendriticum*), pear leaf blight (*Entomosporium maculatum*), pear fire blight, peach yellows, potato blight (*Phytophthora infestans*), rust of cereals (*Puccinia graminis*), smut of grain (*Tilletia fœtens* and *Ustilago segetum*), corn smut (*Ustilago Zeæ-mays*), and ergot (*Claviceps purpurea*).

North Carolina Station, Bulletin No. 77, May 1, 1891 (pp. 8).

VALUE OF PEA-VINE MANURING FOR WHEAT, J. R. CHAMBERLAIN, B. S. (plate 1).—A continuation of an experiment commenced in 1888 and reported in Bulletin No. 72 of the station (see Experiment Station Record, vol. II, p. 372). In 1888–89 seven twenty-fifth-acre plats were laid out so that one half of each plat was on land in which a crop of black cowpeas had been plowed, and the other half on land which

had lain idle during the summer, a space of 10 feet being left between the two halves. Fertilizers consisting of kainit, acid phosphate, and cotton-seed meal, used singly or all three together, were employed on five of the plats, the other two receiving no fertilizer. The plats were sown to wheat (a mixture of Fultz and Fulcaster) at the rate of 1½ bushels per acre. The results showed an average increased yield of 10 bushels of wheat per acre where pea vines had been plowed in.

In 1889–90 the same seven plats were treated as in the preceding year, with the only difference that the pea vines when plowed in were well matured. The winter "was severe on all winter grain," and the wheat growing on the plats where no pea vines had been plowed under was somewhat injured. "The yields on the portion with peas were very good, although not as good as the year before." The fertilizers applied and the yields of wheat are tabulated as follows:

Yields of wheat per acre (1890).

No.	Application of fertilizer per acre.	Cost.	Yield per acre without pea vines.		Yield per acre with pea vines.	
			Bush.	*Lbs.*	*Bush*	*Lbs.*
1	None		12	30	20	50
2	300 pounds kainit	$2.55	4	22½	21	40
3	300 pounds acid phosphate	2.70	4	10	25	50
4	175 pounds acid phosphate; 87½ pounds cotton-seed meal; 37½ pounds kainit	2.94	3	32½	24	10
5	None		1	40	15	50
6	300 pounds cotton-seed meal	3.60	5	..	12	42½
7	350 pounds acid phosphate; 175 pounds cotton-seed meal; 75 pounds kainit	5.88	11	52½	25	25
	Average yield per acre		4	44	20	55

"Especial attention is called to the yield on plat 3 with pea vines. It was the largest yield of any plat, and the cost of fertilizer moderate. This was the plat that produced the largest yield the year previous. So far this experiment proves that acid phosphate used with peas is the cheapest and best fertilizer for wheat."

North Carolina Station, Bulletin No. 77*b* (Technical Bulletin No. 2), July 1, 1891 (pp. 11).

INVESTIGATIONS OF THE ARSENITES WITH REFERENCE TO INJURIES TO FOLIAGE, B. W. KILGORE, B. S.—This is a report of investigations from a chemical standpoint to determine the cause of injury to foliage from the application of arsenites, and to find a means for its prevention. The experiments were made in July, 1890. The conclusions reached agree in general with those obtained from independent experiments at the Iowa Station, an account of which was published in Bulletin No. 10 of that station (see Experiment Station Record, vol. II, p. 215).

Chemical tests made in connection with spraying experiments with solutions containing white arsenic, London purple, or Paris green, and with Bordeaux mixture revealed the fact that "in no case was injury noticeable where soluble arsenic was absent, but in all cases it was proportional to the amount of soluble arsenic."

Seeing in this experiment the insolubility of the arsenites in Bordeaux mixture and the consequent exemption of foliage from injury, and knowing that London purple was, in the main, an arsenite of calcium, being produced by the decomposition of rosaniline arsenite by calcium hydrate (lime in solution), it was at once plain, from a chemical point of view, that lime would render the soluble portion of the arsenites insoluble in water, and thus render foliage free from injury from them. Various mixtures of an equal weight of pure lime (CaO) and white arsenic, London purple, and Paris green, separately in water, were made to test this point. Some of the mixtures contained as much as 4 pounds of arsenite in 100 gallons, but in only a few cases was so much as a trace of soluble arsenic found when tested by sulphureted hydrogen. [The results of the application of these mixtures to foliage are tabulated.] In every case where there was soluble arsenic there was also "burning" of foliage, and this in all cases was in direct proportion to the amount of soluble arsenic. Where there was no arsenic in solution there was no burning of leaves except in one case, where white arsenic and lime had been standing only 24 hours.

Another table shows the amount of soluble arsenic compounds found in 1 and 100 gallons of arsenical mixtures, 1, 3, 5, 7, and 24 hours, and 10 days after mixing, and the entire absence of such compounds when lime was present.

White arsenic, it will be seen, dissolves very slowly, requiring more than 10 days for complete solution, even in a large volume of water and at summer temperature, while the soluble portion of London purple goes into solution practically at once; and the same is approximately true of Paris green. * * * The beneficial effect of lime in the London purple mixture is due to its decomposing action upon the rosaniline arsenite by which insoluble arsenite of lime is formed. This change takes place in a short time, as will be seen from the loss of color of the mixture. Double and triple weights of lime to London purple were experimented with, thinking it might require these amounts to effect the decomposition, but an equal weight was found to be ample.

The beneficial effect of lime in Paris green and white arsenic mixtures is also due to the formation of the insoluble arsenite of lime. Equal weights of lime to Paris green and white arsenic each were found sufficient in all cases, and no more than this, even of the commercial article, need be added to Paris green. But to be on the safe side, I think it best to add 2 pounds commercial lime (CaO) to 1 pound white arsenic. One pound white arsenic (As_2O_3) requires approximately 0.85 pounds of lime (CaO) to satisfy the reaction in the production of the insoluble arsenite, but slight excess of lime does not seem to do any harm—certainly far less than an excess of arsenic.

A very cheap insecticide, having the same insecticidal properties as London purple, can be easily made by boiling together for one half hour, in 2 to 5 gallons of water, 1 pound commercial white arsenic and 2 pounds commercial lime, and diluting to required volume, say 100 gallons.

Other experiments showed—

(1) That Bordeaux mixture prevents the solubility of the arsenites and their injury to foliage by virtue of its lime.

(2) That the arsenites are more soluble in simple solutions of sulphate of copper, sulphate of iron, and chloride of iron than in water, and injure foliage more than when applied in water.

(3) That the arsenites are very soluble in eau celeste and eau celeste modified with soda mixtures, and do very great damage to foliage when applied in them.

(4) That kerosene emulsion is not a favorable medium for applying the arsenites.

North Carolina Station, Bulletin No. 78, July 10, 1891 (pp. 31).

SOME INJURIOUS INSECTS, G. MCCARTHY, B. S. (pp. 5–30, figs. 34).—This includes formulas for ten of the most common insecticides, illustrations of spraying apparatus, and illustrated notes on the following insects: Cotton caterpillar (*Aletia xylina*), bollworm (*Heliothis armigera*), red spider (*Tetranychus telarius*), tobacco worm (*Phlegethontius carolina*), flea beetle (*Crepidodera cucumeris*), greasy cutworm (*Agrotis telifera*), tree cricket (*Œcanthus niveus*), chinch bug (*Blissus leucopterus*), hill worm (*Elater* sp.), corn bill bug (*Sphenophorus zeæ*), corn plant louse (*Aphis maidis*), Hessian fly (*Cecidomyia destructor*), grain plant louse (*Siphonophora avenæ*), angoumois grain weevil (*Gelechia cerealella*), harlequin bug (*Murgantia histrionica*), cabbage caterpillar (*Pieris* sp.), striped cucumber beetle (*Diabrotica vittata*), Colorado potato bug (*Doryphora 10-lineata*), black blister beetle (*Cantharis nuttalli*), pea weevil (*Bruchus pisi*), codling moth (*Carpocapsa pomonella*), cankerworm (*Paleacrita vernata*), apple tree tent caterpillar (*Clisiocampa americana*), plum curculio (*Conotrachelus nenuphar*), peach borer (*Sannina exitiosa*), round-headed borer (*Saperda bivittata*), flat-headed borer (*Chrysobothris femorata*), pear twig girdler (*Oncideres cingulatus*), rose chafer (*Macrodactylus subspinosus*), grapevine leaf roller (*Desmia maculalis*), spotted grapevine caterpillar (*Procris americana*), grapevine flea beetle (*Haltica chalybea*), grape curculio (*Craponius inæqualis*), June bug (*Lachnosterna fusca*).

SOME BENEFICIAL INSECTS, G. MCCARTHY, B. S. (pp. 30, 31, figs. 4).—Brief illustrated notes on ladybugs (*Coccinella* sp.), lace-winged flies (*Chrysopa* sp.), banded soldier bug (*Milyas circinatus*), and tiger beetle (*Passimachus elongatus*).

Ohio Station, Bulletin Vol. III, No. 11 (Second Series), December, 1890 (pp. 72).

NINTH ANNUAL REPORT, 1890.—This includes the reports of the board of control, treasurer (for fiscal year ending June 30, 1890), director, agriculturist, entomologist and botanist, veterinarian, and meteorologist, and the "Insect Record for 1890." The reports consist for the most part of brief outlines and condensed summaries of the work of the year. A table of contents for the bulletins of 1890 is given in an appendix, and brief synopses of these are contained in the director's report. There is also an index to the publications of the year.

Report of Meteorologist, W. H. Baker.—This includes tabulated daily and monthly summaries of observations for the station and the State of Ohio, and a yearly summary for each year from 1883 to 1890, inclusive.

Annual summaries of meteorological observations for the State of Ohio, 1883–90.

TEMPERATURE.

[Degrees F.]

Year.	Mean.	Highest.	Lowest.	Maximum range.	Mean daily range.	Maximum daily range.	Minimum daily range.
1883	49.4	98, Aug. 22	—17.2, Jan. 22	115.5	19.8	55.2, Mar. 18	0.5, Dec. 23.
1884	50.6	99, Sept. 28 and Oct. 1.	—34, Jan. 25	133	20.5	50, Sept. 5 and Dec. 4.	1.1, Feb. 6.
1885	48.0	101, July 21	—31, Jan. 29	132	20.4	58.5, Jan. 30	1.0, Apr. 18 and Dec. 31.
1886	49.6	98.6, July 7	—21.5, Jan. 12	120.1	20.2	57, Dec. 11	1.1, Mar. 27.
1887	51.4	108, July 18	—21, Jan. 7	129	21.2	57, Apr. 11	1.0, Jan. 15 and Apr. 16.
1888	49.5	102	—15, Jan. 27	117	19.6	50	1.2, Jan. 16.
1889	51.1	99.5, Aug. 31	—1[illegible].5, Feb. 24	113	19.3	53, Mar. 30	1.0, Jan. 5.
1890	52.4	103.1, Aug. 3	—4, Mar. 7	107.1	19	49.5, Apr. 11	1.0, Dec. 17.
Summary for 8 years.	50.3	108, July 18, 1887	—34. Jan. 25, 1884	142	20	58.5, Jan. 30, 1885	0.5 Dec. 23, 1883.

HUMIDITY, WIND, AND WEATHER.

Year.	Mean relative humidity.	Yearly rainfall.	Prevailing direction of wind.	Number clear days.	Number fair days.	Number cloudy days.	Number rainy days.
	Per cent.	*Inches.*					
1883	76.3	44.98	SW	98.2	135.4	130.4	146.0
1884	76.8	40.19	SW	116.7	118.3	131.1	145.0
1885	77.5	38.08	SW	103.5	132.8	128.2	147.7
1886	77.8	36.71	SW	118.4	125.7	121.0	130.7
1887	75.8	33.03	SW	113.8	127.3	123.9	120.9
1888	78.2	39.64	SW	108.7	123.4	133.9	124.7
1889	79.4	33.53	SW	112.8	113.8	138.4	114.8
1890	80.2	50.33	SW	103.4	121.6	110.3	149.4
Summary for 8 years	77.7	40.89	SW	109.4	124.7	130.8	134.9

Insect Record for 1890, C. M. Weed, D. Sc.—Brief illustrated notes are given on the following insects, which were more or less prevalent in Ohio during 1890: Woolly maple bark louse (*Pulvinaria innumerabilis*), walnut caterpillar (*Datana angusii*), yellow-necked apple tree caterpillar (*Datana ministra*), white-marked tussock moth (*Orgyia leucostigma*), grain plant louse (*Siphonophora avenæ*), oyster-shell bark louse (*Mytilaspis pomorum*), scurfy bark louse (*Chionaspis furfurus*), buffalo tree hopper (*Ceresa bubalus*), plum curculio (*Conotrachelus nenuphar*), codling moth (*Carpocapsa pomonella*), chinch bug (*Blissus leucopterus*), Hessian fly (*Cecidomyia destructor*), striped cucumber beetle (*Diabrotica vittata*), imported cabbage worm (*Pieris rapæ*), cabbage aphis (*Aphis brassicæ*), willow grove plant louse (*Melanoxanthus salicti*), white pine plant louse (*Lachnus strobi*), potato stalk borer (*Trichobaris trinotata*), and apple maggot (*Trypeta pomonella*).

The following interesting discovery is reported in the case of the cabbage aphis:

During November we discovered that the sexual generation develops late in autumn on the cabbage, and that the eggs are laid on the cabbage leaves. The true male is a small, winged creature, with a more slender body than the other winged forms. The egg-laying female has no wings and is pale green in color.

This discovery of the fact that the insect passes the winter in the egg state on the cabbage leaves has an important economic bearing. It suggests as one of the best ways of preventing the injuries of this pest, the destruction during winter of the old cabbage leaves with the eggs upon them, instead of leaving them undisturbed until spring, as is too often done.

Several kinds of spraying apparatus tested at the station are described and illustrated. The article is illustrated with two plates and nine figures, a number of which are original.

Pennsylvania Station, Bulletin No. 16, July, 1891 (pp. 18).

CHESTNUT CULTURE FOR FRUIT, W. A. BUCKHOUT, M. S. (pp. 3–11).—A discussion of the advantages of cultivating nuts, especially chestnuts, in Pennsylvania.

[The chestnut] is adapted to the climate of Pennsylvania and grows well on the light, gravelly soils of hillsides, though not thriving on heavy limestone land. It may be propagated as a seedling from second growth sprouts, and by grafting of named varieties upon native stocks; varieties, too, may be improved by hybridization. In addition to its fruit its wood is of great value and its bark is used for tanning.

For planting the seed must be kept moist, and must be covered by sand or sawdust until planted, which is best done in the fall, at not too great a depth, and with careful firming. Plant where the trees are to remain, for transplanting is exceptionally injurious to the young chestnut. European and Japanese varieties, though not hardy in our climate, do well on native stalks, produce more and better fruit than our small native variety, and sometimes bear in 4 years. Top-graft on vigorous stalks just starting into growth; cut the scions early, and keep dormant till grafted, as in case of apples. Scions may be obtained from most nurserymen. To secure early and best bearing, trees must not be too closely planted, and bushes and other trees must be cut away sufficiently to prevent interference, so that there shall be a low, round-headed development.

ANALYSIS OF SEVERAL VARIETIES OF CHESTNUTS, W. FREAR, PH. D. (pp. 12–18).—General statements regarding the composition of chestnuts, and tabulated results of analyses with explanatory notes. The following tables are from the bulletin:

Proportion of shell and kernel.

Name.	1	2	3	4	5	6	7	8
	Spanish.	Paragon.	Spanish.	Numbo.	Moon's Seedling.	Solebury.	Native.	Native.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Shell	21.51	23.94	25.25	11.49	14.32	15.32	23.24	22.87
Kernel:								
Water	6.63	6.53	5.43	42.25	47.66	29.17	34.45	4.82
Dry matter	71.86	69.53	69.33	46.26	44.02	55.51	42.31	72.31
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Composition of chestnut varieties—water-free.

	1	2	3	4	5	6	7	8
	Spanish.	Paragon.	Spanish.	Numbo.	Moon's Seedling.	Solebury.	Native.	Native.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*
Crude ash	3.03	3.12	2.87	3.18	3.05	2.51	2.66	2.72
Crude fiber	2.55	2.08	2.81	3.71	3.26	2.53	3.63	2.81
Crude fat	7.11	9.76	9.58	11.46	11.00	11.67	16.12	16.08
Crude protein:								
Albuminoids	8.38	10.91	9.28	8.68	9.63	8.07	11.81	10.53
Amides, etc	1.23	1.23	1.68	1.90	1.11	1.44	0.30	1.67
Total	9.61	12.14	10.96	10.58	10.74	9.51	12.23	12.20
Nitrogen free extract:								
Glucose	5.10	9.13	12.63	6.76	6.71	13.78	14.06	8.50
Dextrine	17.45	11.05	8.23	14.40	14.74	15.02	7.63	12.01
Starch	24.24	32.15	23.87	20.49	33.95	34.27	16.81	50.65
Other material	30.84	19.97	20.02	20.39	16.55	9.73	26.63	
Total	77.70	72.30	73.75	71.04	71.95	72.80	65.03	66.16

*Other analyses of nuts and grains.**

	Dry matter.	Water-free.				
		Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Other analyses of chestnuts:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Payen	45 79	4 04	7.23	....	....	....
Dietrich	51.25	3.21	6.36	87.02		3.41
Nessler and von Fellenburg:						
Marones	(?)	3.16	14.50	3.00	76.73	2.61
Early chestnuts	(?)	3.51	15.75	3.63	74.50	2.61
Late chestnuts	(?)	3.69	12.70	3.34	77.76	2.51
Albini, from a number of Italian varieties, obtained the following:						
Minima	(?)	3.00	5.20	6.50	†63.50	1.20
Maxima	(?)	3.30	9.30	8.40	78.20	2.10
Konig's mean	48.52	3.54	11.29	3.32	79.03	2.82
Other nuts:						
Sweet almonds	94.61	3.13	25.56	6.93	7.64	56.74
Walnuts	95.32	2.13	17.17	6.47	8.28	65.95
Hazelnuts (filberts)	96.23	1.90	16.24	3.40	9.39	69.08
Acorns (shelled)	59 88	2.32	7.21	5.71	80.17	4.59
Peanuts	93.50	3.48	30.21	....	....	49.61
Cocoanuts (meat)	53.36	1.81	10.29	5.45	15.10	67.35
Grains:						
Wheat	86.35	2.09	14.30	2.93	78.65	2.03
Corn	86.88	1.74	11.33	2.87	78.74	5.32
Beans	85.24	3.82	28.47	8.32	57.50	1.89

* From König's work on Human Foods. † Sum of sugar, dextrin and starch.

The principal facts relating to the composition of the chestnut may be summarized as follows:

(1) Chestnuts, like acorns, are starchy rather than oily nuts; they keep better, and are more digestible than the latter, though the air-dry nuts contain much more water; their dry matter is not, however, so rich in protein. The European chestnut closely approaches wheat in composition, but contains less starch and more dextrose and other water-soluble carbohydrates.

(2) The small, uncultivated American chestnuts are more oily than the nuts grown in Europe, and contain less starch, though they differ little from the other varieties in their content in sugars, protein, fiber, etc.

(3) Varieties of European stock, when grown in this climate, though carefully cultivated, and attaining normal size, apparently tend to become more oily, poorer

in carbohydrates, and possibly less albuminous. On the other hand, Moon's Seedling, produced from American stock, had only three fourths as much fat as the native nuts, and less protein, and in general closely resembled the seedlings of European origin grown in the same locality.

Utah Station, Bulletin No. 7, July, 1891 (pp. 19).

DRAFT OF MOWING MACHINES, J. W. SANBORN, B. S.—Accounts are given of dynamometer tests of the draft of mowing machines of several different kinds, in cutting grass, clover, and alfalfa, and under varying adjustments. The following summary is taken from the bulletin:

(1) A difference of draft was found in mowing machines, but not great, save in favor of one machine. This difference seemed to follow speed.

(2) The draft of mowing machines varied in their relations to each other in varying kinds of mowing. This seems to be due to speed; therefore they should have two or more pinions.

(3) The draft of machines varied with the point of attachment for draft.

(4) The draft was 8.7 per cent greater for a well-sharpened sickle than for one more nicely sharpened.

(5) An old machine well repaired drew easier than a new one.

(6) A 6-foot cutter bar drew easier per foot of cut than a 4½-foot cutter bar, and at a draft less than a plow carrying an average furrow; therefore a pair of horses can draw a 6-foot cutter bar.

(7) A pitman box set tight gave a draft less than one run quite loosely.

(8) A heavy loss (7.6 per cent) of force was observed when the truck at the end of the cutter bar failed to roll.

(9) When cutter bar is not near right line with pitman rod the draft is increased.

(10) When guards are not true draft is increased.

(11) When cutter bar is inclined upward the draft is decreased.

(12) The draft was decreased 10 pounds by the driver walking.

(13) When the sections of the sickle do not strike in the center of the guard the draft is increased.

Virginia Station, Bulletin No. 10, June, 1891 (pp. 27).

STEER FEEDING, D. O. NOURSE, B. S. (pp. 4–13).—It was the purpose of this experiment to compare the effects (1) of corn silage and hay, and (2) of whole corn and corn meal, both with regard to gain in live weight and to cost of food per pound of gain. Twelve steers, about 2½ years old, were divided into six lots of two animals each, and after a preliminary period of a week were fed continuously from February 10 to April 14 as follows:

Lot 1, 37 pounds silage with 12 pounds corn meal.
Lot 2, 37 pounds silage with 12 pounds whole corn.
Lot 3, 37 pounds silage with 8 pounds corn meal and 8 pounds bran.
Lot 4, hay *ad libitum* with 12 pounds corn meal.
Lot 5, hay *ad libitum* with 12 pounds whole corn.
Lot 6, hay *ad libitum* with 8 pounds corn meal and 8 pounds bran.

The animals of lots 1, 2, and 3 were also given hay *ad libitum* in addition to the silage, but in the rations of the remaining three lots the coarse fodder consisted entirely of hay.

The results are fully tabulated in the bulletin, and from these the following statement, showing the average per animal for each lot, is taken. In the calculations of the cost of food, corn meal, whole corn, and bran were each reckoned at $20 per ton, hay at $10, and silage at $2.50, and no allowance was made for the value of the manure.

Averages per animal during entire experiment.

Kinds of food.	Dry matter in food consumed.	Gain in live weight.	Total cost of food.	Cost of food per pound of gain.
	Pounds.	*Pounds.*		*Cents.*
Lot 1, silage and corn meal	1,502.1	180	$13.05	7.35
Lot 2, silage and whole corn	1,415.0	127	11.99	9.30
Lot 3, silage, corn meal, and bran	1,697.9	179	14.89	8.30
Average of three lots on silage	1,538.3	162	13.31	8.20
Lot 4, hay and corn meal	1,392.0	128	11.89	9.35
Lot 5, hay and whole corn	1,315.7	69	11.30	17.50
Lot 6, hay, corn meal, and bran	1,533.8	135	13.95	10.35
Average of three lots on hay	1,413.8	110.7	12.38	11.20

Comparing, first, the silage and hay it would seem from the above that in this trial those animals receiving silage consumed the largest amount of dry matter and made a larger gain in live weight than those receiving hay instead of silage; the silage, however, contained a large amount of water, which introduces a factor difficult to make allowance for. The extra amount of water taken into the body may have increased the apparent gain, although there was a continuous increase in weight to the end of the experiment, as will be seen from the following averages:

Gain per animal.

	With silage.	With hay.
	Pounds.	*Pounds.*
First 3 weeks	66.3	43.3
Second 3 weeks	57.7	46.3
Third 3 weeks	38.0	21.0

The sudden falling off in the average amount of gain after the first 6 weeks of feeding is noticeable both where silage and where hay were fed. The average cost of food per pound of increase was 8.2 cents with silage and 11.2 cents with hay.

"It would seem that a variation so great as this would not all be accounted for by individual peculiarities, but rather by the fact that silage is very economical to give in moderate quantities to fattening animals."

As between corn meal and whole corn the data indicate the former to be the most economical, for while the average cost of food per pound of increase in the lots receiving corn meal was 7.35 and 9.35 cents respectively, it was 9.3 and 17.5 cents with those receiving whole corn instead.

"Perhaps the price of whole corn is too high, as it costs considerable to convert it into meal, but allowing one seventh for toll the balance is still much in favor of the meal-fed lot."

PIG FEEDING, D. O. NOURSE, B. S. (pp. 14–27, plates 6).—This experiment was intended to get additional information as to the effect of highly carbonaceous and of highly nitrogenous rations on the development of fat and lean meat in pigs.

Nine pigs were selected for the trial, six of which were Berkshire barrows, about 5 months old at the beginning of the trial, and the remaining three a cross of Poland-China and Jersey Red, which had been at pasture and "were the largest lean hogs, even in size and quality, we could procure"; they were from 7 to 9 months older than the Berkshires. The pigs were divided into three lots of as nearly equal weight as possible, each lot containing two Berkshires and one of the older hogs. Each lot received a different ration, as follows:

Lot 1, corn meal alone; nutritive ratio 1:9.05.
Lot 2, 10 parts corn meal, 4 of bran, and 1 of beef scrap; nutritive ratio 1:5.82.
Lot 3, 5 parts corn meal, 2 of bran, and 2 of beef scrap; nutritive ratio 1:2.35.

Each pig was fed twice daily in a pen by itself, only as much food being given as would be consumed without waste. Ashes, charcoal, and salt were given, but not mixed with the food. The animals were weighed at the end of each week, before feeding.

The experiment was commenced August 19; October 16 two of the pigs in lot 3 died, and October 31 the third one died. An examination showed that "death was probably caused by lack of power to assimilate the food." The feeding of lots 1 and 2 was continued until November 25, when they were slaughtered.

Seven tables give the weights of the animals, food consumed, dry substance consumed per 100 pounds live weight and per pound of increase, cost of food per pound of gain, data obtained at time of slaughtering, etc.; and six plates show cross sections of the carcass of each pig. There was no perceptible difference in the proportion of fat and lean meat in the hogs of the different lots. The cost of the rations is based on corn meal at $20, bran at $20, cotton-seed meal at $25, and beef scrap at $40 per ton, making no allowance for the value of the manure. The gains and cost per pound of gain for lots 1 and 2 were as follows:

Gain per animal, and cost of food per pound of gain.

	Lot 1.				Lot 2.			
	No. 1.*	No. 2.	No. 3.	Average.	No. 4.*	No. 5.	No. 6.	Average.
Weight at beginning of experiment, pounds	130.25	114.50	103.00	115.92	127.00	108.25	109.50	114.92
Gain in live weight during experiment, pounds	140.25	90.75	137.75	122.92	189.50	157.50	153.75	166.92
Cost of food per pound of gain, cents	4.9	6.6	4.4	5.3	4.1	4.8	5.4	4.8

*Had been at pasture previous to the experiment.

The author makes the following inferences from the results:

(1) A very narrow ration is not fed with economy, and may, as in this case, even cause death through lack of power of the animal to assimilate food in so concentrated a form.

(2) Not the slightest difference is made in the proportions of fat and lean meat in pigs fed corn meal alone and corn meal, beef scrap, and bran.

(3) The second lot lost more in 24 hours after being dressed, and slightly more moisture was found in both fat and lean meat when dried at 100°C.

(4) The cost per pound increase in live weight was 0.5 of a cent in favor of the bran-fed lot [lot 2].

(5) The cost per pound of gain in live weight of lot 1 was 5.3 cents, and of lot 2, 4.8 cents. As a whole, the second food was the more economical, owing perhaps to the greater relish with which it was eaten.

Wyoming Station, Bulletin No. 2, August, 1891 (pp. 8).

PLANT LICE, F. J. NISWANDER, B. S. (pp. 27–31, figs. 3).—Brief general notes on plant lice affecting cottonwood trees and the means for their repression.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 87 (NEW SERIES), AUGUST, 1891 (pp. 377–437).—This includes articles on the condition of the growing crops of corn, spring wheat, spring rye, barley, buckwheat, oats, potatoes, tobacco, cotton, grasses, canes, and fruits; European crop report for August; Indian wheat crop of 1891; the Raiffeisen loan associations of Germany; and the freight rates of transportation companies.

Indian wheat.—The final official returns of the Government of India of the wheat crop of 1890–91 make the area under wheat 26,424,000 acres, as compared with 24,773,000 last year, and a normal or average for 5 years of 26,479,000. The product is given as 6,842,000 tons, or 255,434,667 bushels, while that of last year was 6,123,000 tons, or 228,502,000 bushels. Last year was unfavorable for wheat production in India. The increase of acreage of this year over last amounted to 651,000 acres, and of production, 26,842,667 bushels.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. III, NOS. 11 AND 12, AUGUST, 1891 (pp. 433–519, figs. 5).—The principal articles in this double number are: Some Icerya and Vedalia Notes; Experiments with a Date Palm Scale (*Parlatoria zizyphi*, Lucas); A Viviparous Cockroach (*Panchlora viridis*), by C. V. Riley; The Grasserie of the Silkworm, by P. Walker; Observations on Injurious and other Insects of Arkansas and Texas, by F. M. Webster; An Encyrtid (*Hexacladia smithii*, n. sp.) with Six-Branched Antennæ, by W. H. Ashmead; History of the Hydrocyanic Acid Gas Treatment for Scale Insects, by D. W. Coquillett; Some of the Bred Parasitic Hymenoptera in the National Collection (continued); and Description of a New Tortricid (*Semasia bucephaloides*, n. sp.), by Lord Walsingham. The text of the Massachusetts law against the Gypsy moth (*Ocneria dispar*), and the regulations of the state board of agriculture for carrying out the provisions of the law, are given in full. Indexes to vol. III accompany this number.

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

North American Fauna No. 5.

Results of a biological reconnoissance of south-central Idaho, C. H. Merriam (pp. 1-113, plates 4, figs. 4).—The reconnoissance was made by the author and his assistants during August, September, and October, 1890, in Idaho, south of latitude 45° and east of the 38th meridian. The report includes an itinerary, descriptions of the several regions traversed, a provisional definition of the life zones of Idaho, check and annotated lists of the mammals of Idaho with descriptions of new species, an annotated list of birds observed in Idaho during the reconnoissance with notes on species previously recorded from the State, and an annotated list of reptiles and batrachians collected by the expedition, prepared by L. Stejneger.

Idaho presents great diversity of physical features, comprising immense coniferous forests, ranges of lofty rugged mountains, fertile grassy valleys, arid sagebrush plains and alkali deserts, and it is about equally divided between the Boreal [altitudes above 7,500 feet] and Sonoran [altitude below 6,400 feet] life zones. Its mammal fauna is correspondingly rich and varied. Sixty-seven species and subspecies of mammals are now known from the State and the number will be increased by future explorations. The principal additions are likely to come from the bats and arvicoline mice, and, except in so far as the former group is concerned, the numerical relations of the several families are not likely to be disturbed; hence a statement of the number of genera and species in each may be of interest. For convenience subspecies are here treated as species. The Boreal group *Mustelidæ* leads in genera but not in species, having 8 genera and 9 species. The family *Muridæ* comes next in number of genera and outranks the *Mustelidæ* in species, having 7 genera and 13 species, and the number of species is likely to be slightly increased. The *Sciuridæ* is represented by 5 genera and 10 species; the *Cervidæ* by 4 genera and 5 species; the *Bovidæ* by 4 genera and 4 species; the *Canidæ* by 2 genera and 3 species; the *Felidæ* by 2 genera and 2 species; the *Soricidæ* and *Leporidæ* each by 1 genus and 4 species; the *Saccomyidæ* by 2 genera and 2 species; the *Geomyidæ* by 1 genus and 2 species; the *Ursidæ* by 1 genus and 2 species; and the following families by 1 genus and 1 species each: *Hystricidæ, Zapodidæ, Lagomyidæ, Castoridæ, Procyonidæ*. The *Vespertilionidæ* is probably represented by 3 genera and 4 or 5 species. The genera most largely represented in species are, *Arvicola* 5, *Spermophilus* 4, *Lepus* 4, *Sorex* 4, *Tamias* 3. No other genus has more than 2 species.

The new species and subspecies of mammals described are *Sorex idahoensis, S. dobsoni, S. vagrans similis, Onychomys leucogaster brevicaudus, Hesperomys crinitus, Arvicola macropus, A. mordax, A. nanus, Phenacomys orophilus, Evotomys idahoensis, Thomomys clusius fuscus, Lepus idahoensis*. The list of birds includes 157 species. A new subspecies of owl, named the dwarf screech owl (*Megascops flammeolus idahoensis*), is described and illustrated in a colored plate.

Descriptions of a new genus and two new species of North American mammals, C. H. Merriam (pp. 115-119).—A new genus and species of dwarf kangaroo rat (*Microdipodops megacephalus*) from Nevada is described from six specimens collected in Nevada in October and November, 1890; and a new subspecies of red-backed mouse (*Evotomys gapperi brevicaudus*) is described from two specimens collected in the Black Hills of South Dakota in July, 1888.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The grading of bone meal, J. König (*Landw. Ztg. f. Westfalen u. Lippe, 1891, pp. 265, 266*).—Professor König designates as "normal" that bone meal which has been freed of its fat by chemical means (dissolving in benzine, carbon bisulphide, etc.), leaving the gelatin unattacked. It thus contains from 4.5 to 5.2 per cent of nitrogen, and from 19.5 to 23 per cent of phosphoric acid. He states that it is a common practice among manufacturers in Germany to mix with the pure meal prepared in this way meal from which the gelatinous materials have been extracted by treating with superheated steam, thus furnishing a mixture which has a somewhat smaller percentage of nitrogen and a larger percentage of phosphoric acid than the so-called normal meal. The percentage of nitrogen is further dependent on the amount of meat, horn, etc., which is mixed with the bones and which he pronounces of less manurial value than the gelatinous materials of the bones. These other nitrogenous materials can be quantitatively separated from the bones, he says, by shaking with chloroform; being lighter than the bone they rise to the surface. Normal bone meal may contain from 1 to 5 per cent of such materials, but not more than this amount should be present. He suggests that the quality of the bone meal may be safely graded on the basis of the relation of the phosphoric acid to the nitrogen remaining after extraction with chloroform, and he proposes the following classification:

(1) Bone meal containing 4–5.3 per cent nitrogen and 19.5–23 per cent phosphoric acid, and in which after treatment with chloroform the nitrogen and phosphoric acid are in the proportion of 1:4–5.5, is to be designated as *normal bone meal*, or *bone meal No. 0.*

(2) Bone meal containing 3–4 per cent nitrogen and 21–25 per cent phosphoric acid, and in which after treatment with chloroform the proportion of nitrogen to phosphoric acid is as 1: 5.5–8.5, he designates simply as *bone meal.*

(3) Bone meal containing 1–3 per cent of nitrogen and 24–30 per cent of phosphoric acid, the proportion after treatment with chloroform being as 1:8.5–30, he designates as *degelatinized bone meal.*

(4) Only such meal is designated as *raw* as has been prepared by pulverizing raw untreated bones.

(5) Meal which after treatment with chloroform contains less than 1 per cent of nitrogen derived from the bone gelatin, and in which the relation of nitrogen to phosphoric acid is wider than 1:30, is not to be classed as a bone meal, but designated as *mixed fertilizer meal.*

Experiments on continuous growing of grain at Woburn, England, J. A. Voelcker *(Jour. Roy. Agl. Soc. of England, 3 ser., 2, pp. 362–366).*—These experiments were commenced in 1877, and were designed to show the effects of various artificial manures and barnyard manure upon grain crops grown year after year on the same land. The results are here reported*for the years 1889 and 1890, the thirteenth and fourteenth years of the experiments. The plats were one fourth acre each, and the same fertilizers have, except in a few cases, been used each year since 1877 on the respective plats.

Continuous growth of wheat.—The variety of wheat grown was Browick Red, of which 9 pecks per acre were dibbled in by hand in the fall of each year. The fertilizers applied per acre consisted of ammonium salts (sulphate and chloride in equal parts) and nitrate of soda, each in amounts equivalent to 50 pounds of ammonia per acre, used singly; a mixture of 200 pounds of potassium sulphate, 100 pounds of sodium sulphate, 100 pounds of magnesium sulphate and 350 pounds of superphosphate of lime, which was used alone and to which was added, in separate cases, ammonium salts equivalent respectively to 50 and 100 pounds of ammonia, and nitrate of soda equivalent to 50 and 100 pounds of ammonia; rape cake, 800 and 1,600 pounds respectively, furnishing nitrogen equivalent to 100 and 200 pounds of ammonia; and barnyard manure estimated to contain nitrogen equivalent to 200 pounds of ammonia. Two plats have received no fertilizer whatever since 1877, and one plat has received only the mineral fertilizers (potassium, sodium, and magnesium sulphates, and superphosphate of lime). The mineral manures were applied just before seeding, the top-dressings of ammonia salts and nitrate of soda in the spring (April), the barnyard manure early in February, and the rape cake in the latter part of January.

The yields of the duplicate unmanured plats agree very closely in 1889; in 1890 plat 7 is rather higher. Minerals alone, without nitrogen, have as usual given no increase. In 1889 ammonia salts, whether used alone or with mineral manures, produced a larger crop than nitrate of soda, but in the drier year, 1890, the exact reverse was the case, nitrate of soda in each instance then showing the higher return. The appearance of the plats on which these nitrogenous top-dressings are used is in the earlier stages very poor, and the plant is very uneven; nevertheless, toward harvest they seem to pull up wonderfully, and the yield is much more than it has seemed likely to be. The small increase (2 bushels) from putting on in 1889 the double dressing of nitrate of soda is very noticeable, and while the omission of ammonia salts for a single year reduces the grain to 21 bushels, the effect of leaving out nitrate of soda is to take it as low as 11.4 bushels, which is even below the unmanured yield. This greater diminution in the case of nitrate of soda is also very marked in 1890. The effect of rape cake, applied so as to give 100 pounds of ammonia per acre, is greater than that of farmyard manure estimated to contain double that amount. Plat 11*a* [unmanured, having been manured last in 1882 with barnyard manure] still seems to show the presence of some unexhausted fertility from the farmyard manure put on in former years.

Continuous growth of barley.—The fertilizers used in this experiment were the same in kind and amount as those in the experiment with

wheat described above. Golden Melon barley was sown at the rate of 9 pecks per acre. The mineral manures were applied just before seeding, the barnyard manure as a top-dressing just after sowing, the rape cake at about the same time, and the top-dressings of ammonium salts and nitrate of soda in the spring. The indications from the tabulated results are in the words of the author as follows:

Mineral manures produced no increase in 1889, and only about 3 bushels in 1890. The results from the use of nitrate of soda or from ammonia salts when used alone were closely alike both years, but used in combination with minerals, nitrate of soda gave about 2 bushels increase and considerably more straw. Doubling the dressing of nitrate of soda gave only 4 bushels in 1889, and 2 bushels extra in 1890. Rather more relative increase was obtained from doubling the ammonia salts, but nitrate of soda gave the higher total yields. The omission of the top-dressing [of ammonia salts or nitrate of soda] for a single year did not in either season give such marked distinctions as heretofore, between ammonia salts and nitrate of soda when severally omitted. Thus, in 1889, when ammonia salts were left out, the yield fell to 21.9 bushels, and to 18 bushels when nitrate of soda was not put on; but in 1890 the crop grown on the residue of the nitrate of the former year was even higher than that from the ammonia salts. It is only fair, however, to mention that in this year plat *8a* was very patchy indeed. In 1889 neither farmyard manure nor rape cake applied as top-dressing told well, and in 1890 the effect of the rape cake was not nearly so marked, when compared with the farmyard manure, as in the case of the wheat crop.

Experiments with potatoes, J. A. Voelcker (*Jour. Roy. Agl. Soc. of England, 3 ser., 2, pp. 376, 377*).—In this experiment the fertilizers used were (1) manure produced by steers fed on roots, hay, linseed cake 2.8 pounds, barley 4 pounds, and decorticated cotton cake 3.3 pounds per head daily; (2) manure produced by steers receiving the same ration, except that undecorticated cotton cake was substituted for decorticated; (3) a barnyard manure "of indefinite nature;" and (4) a mixture composed of 300 pounds of superphosphate, 300 pounds of kainit, and 200 pounds of sulphate of ammonia per acre. The results follow:

Yield of potatoes per acre.

Plat.	Manure per acre.	Yield per acre.
		Pounds.
1	12 tons dung (decorticated cotton cake)	17,345
2	12 tons dung (undecorticated cotton cake)	14,687
3	12 tons farmyard manure	15,658
4	800 pounds mixed fertilizer	18,987

"By this it will be seen that the artificial manure produced the largest crop, and it is worthy of note that there were no more small potatoes in this produce than in any of the others. The most interesting part of the experiment, however, is that which brings out the superior manurial effect of the decorticated cotton-cake dung as against that from the undecorticated cake."

Relation between the quality of tobacco and its composition, M. Barth (*Landw. Vers. Stat., 39, pp. 81–104*).—The author reviews the investigations of Nessler which recognized the injurious effects of

chlorine compounds and the beneficial effects of potash compounds, especially those with organic acids on the burning qualities of the leaf, and refers to the recognized injurious effects resulting from the use of night soil on tobacco, since it contains considerable quantities of chlorine compounds, induces a coarse growth, etc. Soil to which night soil has been applied for many years may contain so large amounts of chlorine compounds as to be unsuitable for the raising of tobacco, even when the proper fertilizers are applied. Nessler recommended in such cases the preparation of the land for tobacco by previous cropping with such plants as were known to use chlorine compounds in large quantities, as root crops; but in the opinion of the author this practice should be avoided as far as possible, since the root crops not only remove the chlorine, but they also, like tobacco, require large quantities of potash. The potash thus taken away from the soil can not, he believes, be replaced by artificial manures, since the root crops take their potash largely from the supply of potash contained in the soil material itself, which is said to be a form essential to the growth of tobacco also. For, he says, tobacco requires for its most successful cultivation not merely a heavy manuring with potash manures, but also a soil rich in natural potash resources, which by gradual disintegration shall furnish a large proportion of the potash needed by the crop.

Soils which on account of their deficiency in readily soluble potash produce a tobacco with only a small content of potash and of poor burning quality, are designated as "tobacco sick," and will produce a poor quality of tobacco unless by heavy manuring with potash and avoiding the cropping with plants which are heavy potash feeders, for a number of years in succession, opportunity and time are given to recover the supply of soluble potash. For this reason the author recommends that to secure the best results to plant and land, tobacco be planted on the same land only once in 3 or 4 years, or in regions where the land is found to be naturally tobacco sick only once in 5 or 6 years; to plant in the mean time no hoed crops or other fodder plants, but instead cereals, which produce less leaf growth; to give the usual liberal application of barnyard manure either to the intervening crops or to the tobacco itself, and in the latter case the manure should be applied in the fall, as recommended by A. Mayer; and to strenuously avoid the use of all fertilizing materials containing chlorine. He recommends in addition to the barnyard manure a dressing consisting of about 130 pounds of potassium sulphate or 250 pounds of potash-magnesium sulphate, with 90 pounds of Thomas phosphate meal per acre applied in the fall, and 400 pounds of nitrate of soda applied in the spring, half just before the plants are set and the remainder when the plants are about half developed.

With reference to the relations existing between the chemical composition and the quality of tobacco, a large number of examinations have been made under the direction of the author at the experiment station at Rufach, in Alsace, of different varieties of tobacco grown in

1888, 1889, and 1890 in three different localities in Alsace. As a result of these studies the author is led to conclude that the burning quality of the leaf (duration of glowing) is benefited in the highest degree by the presence of large amounts of potash, particularly that combined with organic acids (which in the ash changes to carbonate); by a delicate structure of the leaf (dried leaves, weighing 150 grams or less per square meter, he designates as delicate); and, although in a somewhat less degree, by the presence of considerable quantities of organic nitrogenous substances, especially nicotine, which at the same time has an effect on the quality of the product in general, and by a noticeable content of saltpeter. Detrimental to the burning quality were found to be first of all the chlorine compounds, as already mentioned; a coarse structure of the leaf (leaves weighing 200 grams or more per square meter of dry leaf are designated coarse); and, in a less degree, the presence of any considerable amounts of ammonium salts, phosphoric acid, resinous substances, or calcium salts.

The presence in the same leaf of conditions both favorable and unfavorable to burning quality, which in a test tend to cover up the effects of any single compound or condition, makes it very difficult to determine the effects of any single factor. For this reason Nessler* and later A. Mayer † have studied this matter by impregnating paper with various materials and observing the effect on the duration of glowing. The author pursued this course, using filter paper, which of itself glowed 3 seconds, and straw paper, which glowed 15 seconds, and impregnating in separate instances with 2 per cent solutions of potassium or sodium phosphate, a 3 per cent alcoholic solution of resin, and a solution of 10 grams of fresh liquid egg albumen in 100 c. c. of water. The results with both papers plainly show that in these trials the phosphates, in particular potassium phosphate, and the resins are very detrimental to the protracted glowing, and tend rather to induce charring; the albuminoids, on the contrary, favored a protracted glowing.

The results of A. Mayer's ‡ investigations led him to suggest the impregnation of tobacco of poor burning quality with a half per cent solution of either acetate or nitrate of potash by submerging for 24 hours. He states that he has been able by this treatment to change a poorly burning tobacco, which for this reason could only be used for snuff, to a tobacco of a good burning quality, giving a snow-white ash.

Composition of tomatoes, N. Passerini (*Staz. Sper. Agrar., 18, pp. 545–572; abs. Jour. Chem. Soc., 60, p. 956*).—According to the investigations of Passerini the fresh fruit of tomatoes consists of 1.3 per cent skin, 96.2 per cent pulp and juice, and 2.5 per cent seeds. The pulp contains two coloring matters, a yellow amorphous substance, and a

* Der Tabak, Mannheim, 1867. † Landw. Vers. Stat., 38, p. 130.
‡ Landw. Vers. Stat., 38, p. 138.

red crystalline substance. They are both insoluble in water, soluble in amyl alcohol, and very soluble in ether; and both are decolorized by chlorine water or bromine water. Cold alcohol dissolves the red crystals but slightly, while the yellow compound is very soluble. Hydrochloric acid has no action on either compound.

The juice of the fruit has a specific gravity of 0.01833 at 15° C., and is lævorotatory. It contains a yellow coloring matter which differs from that of the pulp in being soluble in water, insoluble in alcohol, ether, chloroform, and light petroleum, and in not being decolorized by chlorine water or bromine water. The acidity of the juice is said to be due chiefly to citric acid. The juice also contains a small amount of an alkaloid, which, as well as the acid, decreases as the fruit ripens.

The following table shows the percentage composition of the dry matter in the skin, pulp, juice, and seeds:

Composition of different parts of the tomato.

	Water.	Composition of dry matter.			
		Organic matter.	Ash.	Proteids.	Carbohydrates and fat.
	Per cent	*Per cent*	*Per cent*	*Per cent.*	*Per cent.*
Skin	59 50	99.20	0 80	1.85	97.05
Pulp	93 65	89 56	10 44	15 15	74.41
Juice	97 56	74 52	25 48	21.80	*52 72
Seeds	46 30	95.56	4.40	25.40	70.16

* Includes the acid.

The carbohydrates of the skin are chiefly in the form of cellulose.

The following analyses are given of the whole fruit collected in September, 1888, and August, 1889. The first samples were unripe and the second ripe.

Composition of whole tomatoes.

	Unripe fruit.	Ripe fruit.
	Per cent.	*Per cent.*
Moisture at 105° C	93.50	91.01
Composition of dry matter:		
Ash	8.05	12.78
Cellulose	7.83	18.14
Fat and coloring matters	11.73	7.02
Glucose	2.68	41.54
Proteids	11.25	11.48
Citric acid and substances not determined	48.53	9.07

The percentage composition of the ash was as follows:

Potassium oxide	59.46	Phosphoric acid	12.93
Sodium oxide	5.99	Sulphuric acid	3.49
Calcium oxide	1.34	Silica	0.27
Magnesium oxide	3.09	Chlorine	19.14
Ferric oxide	0.22		

In view of the fact that the fruit contains a very large amount of potash and the stems and leaves a large amount of lime (the crude ash of the stems contained 28.32 per cent of lime), the author recommends for tomatoes the use of a fertilizing mixture consisting per acre of about 2¼ tons of barnyard manure, 30 pounds of superphosphate of lime (containing 18 per cent of phosphoric acid), and 55 pounds of muriate of potash (containing 50 per cent of potassium oxide).

Chemical composition and anatomical structure of tomatoes, G. Brissi and T. Gigli (*Staz. Sper. Agrar., 18, pp. 5–34; abs. Jour. Chem. Soc., 60, p. 955*).—The ripe fruit of tomatoes was carefully separated into skin, seeds, and pulp. The pulp formed 85.4 per cent of the whole fruit. The average of several analyses showed it to contain 4.73 per cent of total dry matter, 3.74 per cent of soluble materials, and 1.09 per cent of insoluble materials. The pulp was further separated by filtration through cloth into a red insoluble substance and a yellow liquid, both of which were analyzed. The following table shows the percentage composition (1) of the dry matter of the red insoluble substance, and (2) of the dry matter of the yellow filtrate:

	1	2
Total nitrogen	4.002	2.254
Proteids	25.012	2.430
Coloring matter	21.128	....
Cellulose	34.390	....
Ash	7.959	10.960
Levulose	....	46.680
Citric acid	....	14.030
Amide nitrogen	....	0.641
Amido acid nitrogen	1.224	....

The percentage composition of the ash of the two products was as follows:

	1	2
Potassium oxide	....	58.554
Sodium oxide	....	1.425
Calcium oxide	18 127	1.315
Magnesium oxide	1.423	0.169
Chlorine	....	8.842
Sulphuric acid	....	0.781
Phosphoric acid	15.866	7.182
Carbonic acid	....	18.832
Silica	....	0.451
Not determined	64.584	2.449

Peanut-hull meal, A. Emmerling (*Landw. Wochenbl. f. Schleswig-Holstein, 41 (1891), p. 516*).—According to the author this material is a refuse from the peanut oil manufacture, and has recently been placed upon the market as a feeding stuff for animals. Analyses of six samples of the meal gave the following results:

Composition of peanut-hull meal.

	Minimum.	Maximum.	Average.
	Per cent.	*Per cent.*	*Per cent.*
Water	7.26	8.58	7.95
Ash	3.83	14.31	10.15
Crude cellulose	48.87	58.96	53.66
Crude fat	3.46	5.05	4.11
Crude protein	7.64	8.97	8.23
Carbohydrates	15.88	16.85	16.33

The coefficient of digestibility for the protein, as indicated by Stutzer's method, was found to be 53.3 per cent in one sample and 46.3 per cent in another.

Time of extraction of paper coils in milk analyses by the Adams method, P. Vieth (*Analyst, 16 (1891), p. 128*).—Tests of the "fat-free" paper, prepared for milk analysis by Schleicher and Schüll, showed it to contain 0.0278 per cent of ether extract, or 0.025 per cent when the paper was moistened with dilute acetic acid and then dried before extraction. The latter indicates the absence of any material of a soapy nature. The average amount of ether extract from a strip weighing 6 grams is therefore 0.0016 gram, which would increase the results of a fat determination by 0.03 per cent, "provided the same amount which is extracted in a blank experiment is also got out after 5 grams of milk have been dried on the paper. I am not at all sure that the latter is the case."

With reference to the length of time the ether extraction of the paper coils containing the absorbed milk is to be continued, the author made the following experiments: Two samples of milk, one of whole and one of skim milk, were extracted for different lengths of time with the following results in per cent of fat:

Time of extraction.	Whole milk.	Skim milk.
1 hour	3.48	0.28
2 hours	3.50	0.30
3 hours	3.54	0.28
4 hours	....	0.28

In six samples (three of whole and three of skim milk) the number of siphonings as well as the time of extraction was noted, the object being to find out the shortest time required for extracting the fat. The results follow:

	Sample No. 1.			Sample No. 2.			Sample No. 3.			Sample No. 4.			Sample No. 5.			Sample No. 6.		
Number of siphonings.	3	6	9	3	5	9	3	6	9	3	6	9	3	6	9	3	6	9
Time (minutes)	17	37	52	19	41	59	13	47	41	24	33	51	22	46	64	15	41	50
Per cent of fat	0.28	0.24	0.28	0.22	0.24	0.24	0.24	0.24	0.26	4.18	4.14	4.24	3.54	3.68	3.68	2.84	2.88	2.90

In the cases of samples 3 and 6 there was little increase in fat after the first three siphonings, occupying only about 15 minutes. In the opinion of the author "continuing the extraction for an hour appears to be more than sufficient for all practical purposes."

A comparison of methods of determining fat in milk, L. F. Nilson (*Chem. Ztg., 15, pp. 619–656*).—The primary object of this study of methods was to test the lactocrite and Soxhlet aerometric methods for the rapid determination of the fat in milk, and to compare their accuracy with that of several gravimetric methods. In the course of the investigation considerable information of interest was brought out with regard to the gravimetric methods most generally in use, and chiefly these will be considered here.

In the tests with the lactocrite a mixture of hydrochloric and lactic acids was used for dissolving the casein, instead of a mixture of sulphuric and glacial acetic acids. Of the gravimetric methods in which the milk is absorbed by some porous substance and dried previous to the extraction of the fat, experiments were made with the following:

(1) Pumice stone prepared by grinding and sifting so as to secure a material the particles of which were not over 1 mm. in diameter, washing with water, and igniting. To about 12 grams of this material in a porcelain dish about 12 grams of milk were slowly added, and the whole dried at 97–98° C., the drying being hastened toward the end by placing in an air-tight oven partially exhausted by a filter pump. The dried residue was collected and placed in a paper cartridge made of the best Swedish filter paper, used double, which had been previously extracted with ether for at least 12 hours. A plug of cotton was placed in the bottom of the cartridge and another in the bottom of the extractor to retain the finer particles of pumice. A Soxhlet extraction apparatus and ether free from alcohol and water were used for the extraction. The objection found to pumice stone as an absorbent was that its pores are too large and do not enable a sufficiently fine distribution of the particles of milk solids. The fat globules remain to some extent inclosed in casein, so that a pulverizing of the dried material before extraction becomes essential to accurate results. This method was discarded after a few tests.

(2) The next material used to absorb the milk was unglazed, lightly burnt earthenware, which was reduced to about the same fineness as the pumice stone and washed on a sieve. This was used in the same manner as the pumice stone, except that about 22 grams of the absorbent were used with 10 grams of milk. Tests were made with whole and skim milk as to the time necessary to complete the extraction of the fat. The use of the double paper cartridge and the cotton made the percolation of the ether somewhat slow and thus lengthened the time necessary for the extraction. It was found that from 3 to 5 hours were sufficient for whole milk, but in the case of skim milk containing 0.85 per cent of fat 5 hours seemed not to be sufficient.

(3) Adams method. Examination of Schleicher and Schüll's "fat-free" paper showed that the strips contained a little over 1 mg. each of material soluble in ether, and that 2 hours were sufficient for extraction of this material. In using this method the milk was poured upon the strip, the strip dried for about half an hour, and then extracted in a Soxhlet apparatus. With regard to the duration of this latter extraction, experiments showed 3 hours to suffice for whole milk, but in his comparisons of the Adams method with others the author extracted for 5 hours in case of whole milk and for 12 hours in case of skim milk. The parallel tests by the Adams method agreed more closely than those by any of the other methods tested.

The averages of parallel results obtained in comparisons of the different methods on the same samples of milk are given as follows:

Percentage of fat in milk by different methods.

	Gravimetric methods.			Lacto-crite.	Soxhlet's aerometric method.
	Pumice stone.	Powdered earthenware.	Adams.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Single cow's milk	3.65	3.66	3.74	3.71	3.71
	3.64	3.63	3.73	3.62	3.68
Mixed milk	....	3.09	3.18	3.13	3.18
	2.95*	3.08	....	3.10	....
Single cow's milk	....	2.67	2.76	2.72	2.77
	....	2.55	2.60	2.52	2.56
	....	2.38	2.49	2.43	2.40
Two parts of skim milk and one of whole	....	2.19	2.28	2.23	2.34
Mixed milk 24 hours old	....	1.35	1.43	1.41	1.47
Mixed milk 48 hours old	....	0.85	0.94	0.90	1.02
Centrifugal skim milk	....	0.76	0.86	0.86	1.94
	....	....	0.74	0.69	....
	....	....	0.48	0.42	....
	....	0.31	0.40	....	0.50
	....	....	0.33	0.28	....

* Not powdered after drying.

The differences between the results by the Adams method, the earthenware method, and the lactocrite are expressed in the following statement:

	Maximum.	Minimum.	Average.
Differences between—			
Adams and earthenware	+0.11	+0.05	+0.088
Adams and lactocrite	+0.11	+0.02	+0.052
Lactocrite and earthenware	+0.06	−0.03	+0.035

The author feels certain that the invariably higher results by the Adams than by the earthenware method can not be attributed to the presence of an unaccounted-for ether extract in the paper, and is inclined to the view that owing to the fineness of the interstices of the paper the fat globules are not able to penetrate the paper and so remain on the surface, largely freed from milk serum, where they are more advantageously exposed to the solvent action of the ether.

The powdered earthenware is not required to be extracted with ether previous to use, and can be used over and over again by igniting after use, as the milk ash remaining behind tends to improve it as an absorbent.

(4) Supplementary to these observations the author made a series of tests in which the milk was dried on kaolin. For this purpose very fine particles of kaolin, separated by means of water, were formed into plates, which were baked and afterwards ground to pieces 0.5 to 1 mm. in diameter. Twenty-five grams of this was used with 10 grams of milk, and the operation carried on as with earthenware. The results with whole milk and with skim milk agreed very closely with those obtained by the Adams method. This method is believed to be in every way equal to the Adams, and to present certain advantages over those where other absorbents are used.

As a result of his investigations the author is led to the following conclusions:

(1) The lactocrite, when a mixture of hydrochloric and lactic acids is used, gives results reliable and comparable with those by the best gravimetric methods, whether the milk be rich or poor in fat.

(2) Kaolin prepared as described gives results in close agreement with those by the Adams method.

(3) The Adams method gives thoroughly reliable results, provided the strips of paper are thoroughly extracted with ether before using.

(4) The Soxhlet aerometric method is less reliable than either the Adams or kaolin methods or the lactocrite; with milks containing less than 2.5 per cent of fat it is unreliable, and with milk rich in fat it gives sometimes too high and sometimes too low results.

The curdling of milk during thunderstorms, Tolemei (*Abs. Milch Ztg., 20 (1891), p. 519*).—The author subjected fresh milk to currents of electricity of different intensities, and under varying circumstances, but in no instance did the souring of the milk seem to be hastened. On the contrary the souring seemed rather to be retarded, for while milk which was not treated with electricity was sour in 3 days, the milk treated remained sweet for from 6 to 9 days.

After showing in this manner that the electricity is not the direct cause of the souring, experiments were made on the effect of ozone on milk, in which ozone prepared by the Holtz electric machine was slowly conducted through milk. The milk so treated was found to curdle after a few hours. He concluded that the curdling of milk is therefore not attributable directly to the electricity, but rather to the action of the ozone which is formed by the lightning.

The influence of milk preservatives, A. W. Stokes (*Analyst, 16 (1891), pp. 122–126*).—The author has made a study of the acidity of milk in from 400 to 500 samples. In these investigations the acidity was determined by means of decinormal soda solution, using phenolphthalein as an indicator. His observations led him to believe that

milk as delivered to the London trade is always acid, the acidity being equal on an average to 0.2 per cent of lactic acid.

Such an amount of acidity usually develops in the milk within 8 hours of its coming from the cow. In England, according to the temperature, in from 30 to 40 hours after it has reached an acidity of 0.2 per cent its acidity rises to 0.35 or 0.4 per cent, at which point it has acquired an acid taste and is said to be sour. Usually at an acidity of 0.6 to 0.7 per cent it separates or coagulates. If kept for a long period milk rarely develops a greater quantity of lactic acid than 2 per cent. In some milk, the acidity of which I determined, the highest acidity found was 2.34 per cent after 117 days of keeping. The reason of this is that when this amount of acidity is reached the acid formed is destructive to the fungus forming it. Milk that has not yet developed an acidity of 0.3 per cent but is near it, will coagulate on boiling; it is therefore customary in the trade to test the freshness of a milk, if it is suspected to be stale, by boiling it.

To study the effect of different preservatives on milk not sealed up, a large quantity of the same milk was divided into 11 parts. One part was kept in its original state, another part was boiled, and to the other parts carbonate of soda, potash, salicylic acid, borax, boracic acid, and a mixture of equal parts of borax and boracic acid were added. The acidity was determined in all the samples at intervals of about 4 hours, the sample being thoroughly mixed each time the acidity was determined. In these experiments boracic acid proved the best preservative. When this was used at the rate of two parts per thousand the milk kept sweet for 42 hours longer than milk without any preservative. Boiling milk proved as efficacious as any preservative used at the rate of one part per thousand.

His method of detecting borax in milk is given as follows:

On a porcelain slab place one drop of the milk with two drops of strong HCl and two drops of a saturated turmeric tincture. Dry this on the water bath, take it off directly it is dry, cool, and add a drop of ammonia by means of a glass rod. A slaty blue color changing to green is produced [if borax is present]. I found that a drop of milk containing the thousandth of a grain of borax would give the reaction; even less than this will give the green tint, but not the blue. The turmeric tincture must be fresh, otherwise it is best to use the powdered turmeric.

For rapidly determining the acidity of milk in the trade he recommends the use of compressed pellets containing weighed amounts of carbonate of soda and phenol-phthalein.

In the discussion which followed Dr. P. Vieth said he was quite sure that if the experiments were repeated during the summer and autumn the results would be very different from those obtained by the author from January to May. There was no doubt milk soured much more quickly in summer and autumn, October and November being the most troublesome months. Farmers attributed this to the decaying leaves, and this was perhaps not far from the truth. His own experience was that as soon as an acidity of from 1 to 1.5 per cent was reached fermentation practically ceased, or at any rate proceeded with extreme slowness. With reference to the retarding action of boracic acid on lactic fermentation, other experimenters had not got such good results as Mr. Stokes.

He thought the method proposed for determining the acidity of milk was the most simple, handy, and reliable that could be placed in the hands of the practical cheesemaker.

The occurrence of common salt at different altitudes, A. Müntz (*Compt. rend., 112 (1891), pp. 447–449*).—Rain water collected at high altitudes was found to be very poor in sodium chloride, as is indicated by the following figures:

Rain in high mountains (8,650 feet)	0.34 mg. of salt per liter.	
Rain in low land:		
Bergerac	2.50	Do.
Joinville-le-Pont	7.60	Do.

Water from streams in the Pyrenees contained on an average 0.9 mg. of salt per liter. The author gives the following figures as indicating that plants growing at a high altitude contain much less chlorine than those growing on the plains below, the distance from the sea being the same in both cases:

Percentage of sodium chloride.

	Mountains.	Plains below.
Hay	0.254	1.017
White clover	0.285	0.505
Thyme	0.145	0.238
Rye straw	0.054	0.127

The milk of cows from mountainous regions was found to contain on an average 1.083 grams and that of cows from the lower land 1.35 grams of sodium chloride per liter.

Treatment of apple scab and of grape and gooseberry mildew, J. Craig (*Canada Central Expt. Farm Bul. No. 10, April, 1891, pp. 15*).—Brief popular statements regarding apple scab (*Fusicladium dendriticum*), grape mildew (*Peronospora viticola*), and gooseberry mildew (*Sphærotheca mors-uvæ*), with suggestions regarding the treatment of these diseases. Short accounts are given of experiments under direction of the author with ammoniacal carbonate of copper and other fungicides.

Recommendations for the prevention of damage by some common insects of the farm, the orchard, and the garden, J. Fletcher (*Canada Central Expt. Farm Bul. No. 11, May, 1891, pp. 36, figs. 28*).—General statements regarding insects, means of repression, spraying apparatus, and the preparation and use of various insecticides. Notes are also given on the following insects, with suggestions as to remedies: American frit fly (*Oscinis variabilis*), clover seed midge (*Cecidomyia leguminicola*), Hessian fly (*Cecidomyia destructor*), pea weevil (*Bruchus pisi*), wheat midge (*Diplosis tritici*), wheat stem maggot (*Meromyza americana*), apple aphis (*Aphis mali*), beautiful wood nymph (*Eudryas grata*), cankerworms (*Anisopteryx vernata* and *A. pometaria*),

codling moth (*Carpocapsa pomonella*), fall webworm (*Hyphantria cunea*), flat-headed apple tree borer (*Chrysobothris femorata*), grapevine flea beetle (*Haltica chalybea*), grapevine leaf hopper (*Erythroneura vitis*), imported currant worm (*Ægeria tipuliformis*), imported currant sawfly (*Nematus ribesii*), oyster-shell bark louse (*Mytilaspis pomorum*), pear tree slug (*Selandria cerasi*), plum curculio (*Conotrachelus nenuphar*), raspberry borer (*Oberea bimaculata*), raspberry cane maggot (*Anthomyia* sp.), raspberry sawfly (*Selandria rubi*), raspberry plume moth (*Oxyptilus nigrociliatus*), red-humped caterpillar of the apple (*Œdemasia concinna*), round-headed apple tree borer (*Saperda candida*), tent caterpillar (*Clisiocampa americana* and *C. disstria*), cabbage aphis (*Aphis brassicæ*), cabbage maggot (*Anthomyia brassicæ*), Colorado potato beetle (*Doryphora 10-lineata*), cucumber flea beetle (*Epitrix cucumeris*), cutworms (*Noctuidæ*), imported cabbage butterfly (*Pieris rapæ*), onion maggot (*Phorbia ceparum*), radish maggot (*Anthomyia radicum*), squash bug (*Anasa tristis*), striped cucumber beetle (*Diabrotica vittata*), and turnip flea beetle (*Phyllotreta vittata*).

Corn as a fodder plant, W. Saunders (*Canada Central Expt. Farm Bul. No. 12, June, 1891, pp. 3–15*).—General statements are made regarding the advantages of growing corn for fodder in Canada, time of cutting, selection of varieties, and methods of cultivation and storage. Tabulated data are given for tests of 32 dent, 16 flint, and 41 sweet varieties of corn, together with 2 varieties of pop corn, and for an experiment in planting corn at different distances. The cost of raising and storing corn for silage, as calculated for an experiment at the experimental farm, was about $1.25 per ton.

From the results given it would appear that the Thoroughbred White Flint, Long White Flint, Long Yellow Flint, Yellow Dutton, Large White Flint, Pearce Prolific, and Longfellow are the most productive of the flint varieties, ranging in yield in the order named, and all of them excepting the Long White Flint attained a sufficient degree of maturity to make excellent silage.

Among the different sorts of dent corn, none of which, however, mature as well as the flint varieties, the following have been found to yield the greatest weight of crop: Virginia Horse-Tooth, Golden Beauty, Golden Dent, Blount Prolific, Mammoth Southern Sweet, and Red Cob Ensilage.

Many sorts of sweet corn have given a large yield, the most prolific being Mammoth Sugar, Crosby, Eight-Rowed Sugar, Egyptian Sugar, and Asylum Sweet. The earliest-ripening among these is the Crosby.

Chemical composition of certain varieties of corn, F. T. Shutt (*Canada Central Expt. Farm Bul. No. 12, June, 1891, pp. 16–21*).—Analyses with reference to feeding value are given of samples of Queen of the Prairie, Angel of Midnight, Virginia Horse-Tooth, Golden Beauty, Early Adams, Long White Flint, and Mammoth Southern varieties of corn (whole plant), collected August 26 and September 19; analyses of samples of corn silage taken from the silo December 4 and March 5; and a calculation of the digestible nutrients per ton in each at each

date. The analyses show, with reference to the composition of the corn at different dates, that—

(1) The percentage of water in corn fodder cut August 26 was considerably greater than that in the samples taken September 19.

(2) The percentage of ash in the dry matter decreased materially as the plant matured.

(3) The percentage of albuminoids had decreased slightly in the dry matter during the period of growth between August 26 and September 19.

(4) The percentages of fat, fiber, and carbohydrates had increased during the same period, the two former, however, not to any marked extent.

The analyses of silage show a slight increase in the percentages of protein, fat, and cellulose, and a decrease in carbohydrates from December 4 to March 5.

Report on the progress of the work of the experimental farms of the Dominion of Canada, W. Saunders (*Canada Central Expt. Farm Bul. No. 13, June 2, 1891, pp. 16*).—An outline of the work of the experimental farms during 1890 presented to the Committee on Agriculture and Colonization of the House of Commons of the Dominion of Canada. Details of this work were published in the Annual Report of the experimental farms for 1890.

Variations in the fat of milk drawn from the bottom of the can, H. H. Dean (*Ontario Agr. College Expt. Sta. Bul. No. 66, June 28, 1891, pp. 7*).—These tests were undertaken to determine whether or not, in delivering milk to customers by drawing it through a faucet at the bottom of the can, there is a difference between the milk served first and that drawn last, so that each customer does not get his fair share of fat. Tests were made by the Babcock centrifugal method of the fat in milk drawn by four different milkmen at different intervals during the delivery. The tabulated results show practically no difference in the percentage of fat in the milk drawn from the same can at different times, the variations noted being all within the errors of analysis liable to occur with the method employed.

Winter-wheat experiments, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Sta. Bul. No. 67, August 12, 1891, pp. 12*).—Tests were made of 51 varieties, 24 Canadian and American, and 27 foreign. None of the foreign varieties proved equal to the others. Tabulated data are given for 23 of the Canadian and American varieties.

(1) The bald wheats have given on an average 9.86 bushels or 21.42 per cent more per acre than the bearded varieties, but the latter have weighed on an average 1.37 pounds more per bushel.

(2) The white wheats have given an average of 5.18 bushels more per acre than the red wheats, and they also stand higher in the estimation of the millers than the latter.

(3) The bald white chaff white wheats gave an average of 13.6 bushels per acre more than the bearded red chaff red wheats.

(4) The seven leading varieties in point of yield were all white wheats except the American Bronze.

(5) The four best-yielding white wheats for 1891 were the Garfield [64 bushels per

acre], Surprise [63 bushels], Canadian Velvet Chaff [60 bushels], and Bonnell [59 bushels]; and the four best yielding varieties of red wheat were the American Bronze [65 bushels], Early Red Clawson [58 bushels], Red Velvet Chaff [57 bushels], and Jones Winter Fyfe [56 bushels].

(6) The four best-weighing varieties were the Manchester, Bulgarian, Lancaster, and Democrat, each of which gave 64¼ pounds per bushel.

(7) The three Velvet Chaff varieties gave an average yield of 4.77 bushels per acre in excess of the mean average of the 23 varieties, and weighed 0.22 pound more per bushel, and they are also included in the leading varieties mentioned in conclusion (5).

(8) Of the varieties enumerated in this bulletin the Dominion Millers' Association recommend the following as the most serviceable for milling purposes, viz: Of the white wheats, the Surprise, Canadian Velvet Chaff, and Bulgarian; and of the red wheats, Jones Winter Fyfe, Hybrid Mediterranean, and the Longberry Red.

EXPERIMENT STATION NOTES.

ALABAMA COLLEGE STATION.—The office of director has recently been abolished and its duties have been assigned to the president of the board of direction, who is also president of the college. Isaac Ross, A. M. Lloyd, B. S., and W. B. Fraser are no longer members of the station staff.

ALABAMA CANEBRAKE STATION.—The station has recently suffered a severe loss in the death of H. A. Stollenwerck, a member of the governing board and treasurer of the station. A. Sledge of Whitsett, Alabama, has been appointed a member of the governing board vice S. W. John, resigned. Dr. T. J. Kean has been elected veterinarian.

COLORADO STATION.—A revised edition of Bulletin No. 13 on the measurement and division of water was issued July, 1891. Besides numerous changes, principally verbal, some portions of the bulletin have been recast and a few paragraphs have been added.

KANSAS STATION.—H. M. Cottrell, M. S., has accepted a position as farm manager for Vice President Morton. His present address is Rhinecliff, N. Y.

LOUISIANA SUGAR STATION.—J. T. Crawley, B. A., has been appointed chemist to the station vice W. Wipprecht, resigned.

MICHIGAN COLLEGE AND STATION.—Eugene Davenport, M. S., professor of agriculture in the college and agriculturist to the station, has gone to Brazil, where he is to organize an agricultural college in the Province of Sao Paulo. F. J. Niswander, assistant in entomology, has been appointed professor of agriculture in the University of Wyoming. E. A. Burnett, B. S., assistant in agriculture, has been made assistant professor of agriculture. A. B. Peebles, B. S., assistant chemist of the station, has accepted the professorship of chemistry and physics in the Connecticut Storrs Agricultural School. H. J. Hall, B. S., assistant horticulturist, has accepted a professorship in the University of Arizona, and F. B. Mumford, B. S., has been appointed assistant agriculturist to the station.

NEVADA COLLEGE AND STATION.—J. W. Phillips, D. Sc., has given up his connection with the station and has been transferred to the faculty of the university; N. E. Wilson takes his place as chemist to the station. R. H. McDowell, B. S., formerly of the Colorado Agricultural College and Station, has been appointed horticulturist to the Nevada Station. The station is devoting itself largely to experiments in the culture of sugar beets; experiments with tobacco, a new crop for this region, are also in progress.

OHIO STATION.—Under the recent act of the legislature authorizing various counties of the State to raise money by taxation for the purpose of securing the location of the station, the commissioners of Wayne County have submitted to the people of that county a proposition to raise $85,000 for this purpose. This will be voted upon at a special election, and if it should be ratified the station will be located within that county. H. J. Detmers, D. V. M., is no longer a member of the station staff.

VIRGINIA STATION.—The address of C. Ellis, M. D., formerly veterinarian of the station, is at present Springborough, Ohio.

CENSUS BULLETIN NO. 103.—This gives the statistics on horses, mules, and asses on farms, and was prepared by Mortimer Whitehead.

"The figures of the tables show that in the States and Territories there were on hand June 1, 1890, 14,976,017 horses, 2,246,936 mules, and 49,109 asses; that in 1889 there were foaled 1,814,404 horses, 157,105 mules, and 7,957 asses; that there were sold in the same year 1,309,557 horses, 329,995 mules, and 7,271 asses; and that there died from all causes 765,211 horses, mules, and asses during the same period.

"The increase of horses from 1880 to 1890 is shown to be 44.59 per cent, as against 44.95 per cent between 1870 and 1880, and 14.34 per cent between 1860 and 1870. The increase of mules from 1880 to 1890 was 26.66 per cent; between 1870 and 1880 the increase was 61.08 per cent, while from 1860 to 1870 there was a decrease of 2.24 per cent.

"Of the aggregate number of horses and mules in the whole country June 1, 1890, 86.95 per cent were horses and 13.05 per cent were mules. The North Atlantic group of States had the smallest proportion of mules—2.41 per cent, while the South Atlantic group had the largest proportion—32.04 per cent, as against 67.96 per cent of horses."

CENSUS BULLETIN NO. 111.—This is the first report ever made through the Census Office of the statistics of the seed farms of the United States. The bulletin was prepared by J. H. Hale. Only such farms as were devoted to seed growing as a business are included.

The report shows "a total of 596 farms in the United States devoted exclusively to seed production. These farms occupy 169,851 acres of land, of which 96,567½ acres were reported as devoted to seed production during the census year, divided as follows: 1,437 acres of asparagus, 12,905 of beans, 919 of beets, 1,268 of cabbage, 569 of carrots, 11 of cauliflower, ½ of celeriac, 71 of celery, 13 of collards, 1½ of corn salad, 15,004 of sweet corn, 16,322 of field corn, 1½ of cress, 10,219 of cucumbers, 39¾ of dandelion, 252 of egg plants, 16 of endive, 105 of kale, 19 of kohl-rabi, 13½ of leek, 486¼ of lettuce, 5,149 of muskmelons, 3,978 of watermelons, 2 of nasturtium, 13 of okra, 3,560 of onions, 352 of onion sets, 75 of parsley, 374 of parsnips, 7,971 of peas, 365 of peppers, 4,102 of potatoes, 105 of pumpkins, 662 of radishes, 25 of rhubarb, 26 of salsify, 150 of spinach, 4,356 of tomatoes, 885 of turnips, 4,663 of squashes, and 81 of flower seeds. [This industry represents a total value of farms, implements, and buildings of $18,325,935, and employed in 1890 13,500 men and 1,541 women.] * * * Of the 596 seed farms in the United States, 258, or nearly one half, are in the North Atlantic division, the original center of seed production. These farms have an acreage of 47,813, or an average of 185 acres per farm, while in the north-central division there are 157 farms with an acreage of 87,096, or an average of 555 acres per farm. The seed farms of Massachusetts and Connecticut average 142 acres per farm, while those of Iowa and Nebraska are 695 acres in extent, and are producing seeds on a scale of equal magnitude to the other products of that section of the country. Several of these seed-producing farms embrace nearly 3,000 each. * * * So far as reported there were but 2 seed farms in the country previous to 1800 (one of these was established in Philadelphia in 1784, and the other at Enfield, New Hampshire, in 1795), only 3 in 1820, 6 in 1830, 19 in 1840, 34 in 1850, 53 in 1860, 100 in 1870, 207 in 1880, and 200 more were established between 1880 and 1890, leaving 189 unaccounted for as to date of establishment."

AMERICAN POMOLOGICAL SOCIETY.—The twenty-third biennial session of this society was held at Washington, September 22–24, 1891. Papers were presented on the following subjects: Results of Recent Experiments with Small Fruits, T. T. Lyon, South Haven, Michigan; How to make Small-Fruit Culture Pay, J. H. Hale, South Glastonbury, Connecticut; New and Promising Small Fruits, J. T. Lovett, Little Silver, New Jersey; Recent Progress in the Treatment of Diseases of Pomaceous Fruits, B. T. Galloway, U. S. Department of Agriculture; Chemistry of Peach Yellows, E. F. Smith, U. S. Department of Agriculture; Pruning for Citrus and other Fruits for Florida, D. W. Adams, Florida; Fertilization, Crossing, and Hybridization of Plants, C. E. Bessey, University of Nebraska; Immediate Effects of Cross-Fertilization as Affecting Quality and Commercial Value of Citrus Fruits, Lyman

Phelps, Sanford, Florida; Heredity and Environment in Originating New Fruits, Thomas Meehan, Germantown, Pennsylvania; Fruit Districts Geologically and Climatically Considered, E. S. Goff, experiment station, Madison, Wisconsin; Recent Advance in Dealing with Insects Affecting Fruits, C. V. Riley, U. S. Department of Agriculture; Does the Spraying of Orchards with Insecticides pay? C. M. Weed, College of Agriculture, Hanover, New Hampshire; Some Local Pomological Problems, Charles W. Garfield, Michigan; Pomology in the Eleventh Census, Mortimer Whitehead, U. S. Census Bureau; Apple Growing Commercially Considered, F. Wellhouse, Fairmont, Kansas; Commercial Peach Growing, J. F. Taylor, Douglas, Michigan; Section *vs.* Whole Roots in Propagating the Apple, J. L. Budd, Ames, Iowa; Novelties in Pomology, H. E. Van Deman, U. S. Department of Agriculture; General Fruit Growing, G. C. Brackett, Lawrence, Kansas; Fruit Notes from a Canadian Standpoint, L. Wolverton, Grimsby, Ontario; The Grapes of Middle Virginia, Henry L. Lyman, Charlottesville, Virginia; Small-Fruit Growing in Eastern and Middle North Carolina, J. Van Lindley, Pomona, North Carolina; Pomological Resources of North Carolina, W. F. Massey, College of Agriculture, Raleigh, North Carolina; Pear Blight and Climate Influences, G. F. B. Leighton, Norfolk, Virginia; The Rooted Cutting System of Transplanted Trees, H. M. Stringfellow, Hitchcock, Texas; Fruits of Western North Carolina, H. S. Williams, Rockledge, Florida; Judging Citrus Fruits, J. E. Cutter, Riverside, California.

FOREIGN PUBLICATIONS.—In a recently published article on *Feeding Experiments at the North American Experiment Stations** Dr. Martin Wilckens, who visited a large number of the stations in this country during 1888 as a representative of the Austrian Government, discusses the silage system of the United States and Canada, and gives quite full abstracts of the work done at the Illinois, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, Mississippi, New York (State and Cornell) Ohio, Pennsylvania, Tennessee, Texas, Vermont, Virginia, and Wisconsin Stations on the preparation, composition, and feeding value of corn silage, and makes brief mention of experiments in other lines at the New Hampshire, Iowa, Maine, Michigan, and Mississippi Stations. He believes the teachings of many of these investigations to be applicable to the conditions prevailing in Europe.

The tenth revised and considerably enlarged edition of Prof. Julius Kühn's work on feeding—*Die zweckmässigste Ernährung des Rindviehs*—has recently been issued at Dresden.

The Office has received through the Department of State from W. D. Warner, United States Consul at Cologne, Germany, a copy of a work entitled *Die Düngung der wichtigsten tropischer Culturpflanzen*, by Dr. A. Stutzer, director of the experiment station at Bonn.

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*Jour. f. Landw., 39, pp. 17-35

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

ISSUED DURING SEPTEMBER, 1891.

DIVISION OF ENTOMOLOGY:

Periodical Bulletin, vol. III, Nos. 11 and 12, August, 1891.—Insect Life.

DIVISION OF STATISTICS:

Report No. 88 (new series), September, 1891.—Report on Condition of Crops in America and Europe; Freight Rates of Transportation Companies.

DIVISION OF VEGETABLE PATHOLOGY:

Bulletin vol. VII, No. 1.—Journal of Mycology.

BUREAU OF ANIMAL INDUSTRY:

Special Report on the Cause and Prevention of Swine Plague.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 2, September, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS.

DURING SEPTEMBER, 1891.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:
  Third Annual Report, 1890.
THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 109, August, 1891.—Fertilizers.
STORRS SCHOOL AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 7, September, 1891.—Chemistry and Economy of Food.
AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:
  Bulletin No. 17, August, 1891.—Experiments with Wheat, 1890–91; Daily Variations in Milk and Butter Production of Cows.
AGRICULTURAL EXPERIMENT STATION OF INDIANA:
  Bulletin No. 36, August, 1891.—Field Experiments with Wheat; Testing Grain; Wheat Scab; Forms of Nitrogen for Wheat.
IOWA AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 14, August, 1891.—Effect of Food upon the Quality of Milk; Calf-Feeding Experiment; A Feeding Experiment for Milk; Pig-Feeding Experiment; Reports on Entomological Work; Breeding of Orchard and Garden Fruits; An Aphthous Affection Among Dairy Cows of the State.
KANSAS AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 20, July, 1891.—Experiments with Wheat.
  Bulletin No. 22, August, 1891.—Smut of Oats in 1891; Test of Fungicides to Prevent Loose Smut of Wheat; Spraying to Prevent Wheat Rust.
KENTUCKY AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 34, August, 1891.—Commercial Fertilizers.
  Bulletin No. 35, September, 1891.—Experiments with Wheat and Oats.
MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:
  Annual Report, part IV, 1890.
MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION:
  Bulletin No. 41, September, 1891.—Weather Record, July and August, 1891; Analyses of Commercial Fertilizers; Feeding Experiments with Milch Cows.
HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:
  Meteorological Bulletin No. 32, August, 1891.
AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF MINNESOTA:
  Bulletin No. 16, April, 1891.—Sheep Scab and How to Cure it.
  Bulletin No. 17, August, 1891.—Migratory Locusts in Minnesota in 1891.
  Bulletin No. 18, September, 1891.—Notes on Strawberries, Raspberries, Sand Cherries, Buffalo Berries, and Russian Mulberries; Evergreens from Seed; Summer Propagation of Hardy Plants.
NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS:
  Annual Reports, 1890.
AGRICULTURAL EXPERIMENT STATION OF NEW MEXICO:
  Bulletin No. 3, June, 1891.—A Preliminary Account of some Insects Injurious to Fruits.

Cornell University Agricultural Experiment Station:

Bulletin No. 29, July, 1891.—Cream Raising by Dilution; The Effect of Delay in Setting on the Efficiency of Creaming; Application of Babcock Centrifugal Method to the Analysis of Milk, Skim Milk, Buttermilk, and Butter; The Relation of Fibrin to the Effectual Creaming of Milk.

Bulletin No. 30, August, 1891.—Some Preliminary Studies of the Influence of the Electric Arc Lamp upon Greenhouse Plants.

North Carolina Agricultural Experiment Station:

Bulletin No. 75, April 15, 1891.—Fertilizers.

Bulletin No. 79, July 20, 1891.—Facts for Farmers.

Ohio Agricultural Experiment Station:

Bulletin vol. IV, No. 3 (second series), August 1, 1891.—Commercial and other Fertilizers on Wheat.

Bulletin vol. IV, No. 4, August 25, 1891.—Experiments in Wheat Seeding, including Treatment of Seed for Smut; Comparative Test of Varieties of Wheat.

Rhode Island State Agricultural Experiment Station:

Bulletin No. 10, May, 1891.—Mixed Foods in Cases of Faulty Appetite in Horses and Neat Stock; Patented and Proprietary Foods: Sore Shoulders in Horses.

Vermont State Agricultural Experiment Station:

Fourth Annual Report, 1890.

EXPERIMENT STATION RECORD.

Vol. III. ISSUED NOVEMBER, 1891. No. 4.

EDITORIAL NOTES.

The annual meeting of the German Association for the Advancement of Science (*Gesellschaft deutscher Naturforscher und Aerzte*) was held in Halle, September 21–25, 1891. This Association was organized in 1822. It includes thirty-two sections, of which ten may be reckoned as representing general mathematical and physical science, and twelve as more especially relating to medicine and surgery. The Halle meeting was the sixty-fourth in the history of the Association. The number of members and associates (*Theilnehmer*) in attendance was reported as about 1,300, and included many of the leading scientific men of Germany and a number from other countries. Addresses of general interest were delivered at the general sessions, and many papers representing the latest and best research in special lines were presented and discussed at the meetings of the several sections. The next year's meeting is to occur in Nuremberg.

The sessions of the Section for Agricultural Chemistry and Agricultural Research (*Abtheilung für Agrikulturchemie und landwirtschaftliches Versuchswesen*) were of marked interest. Among the well-known German investigators present were von Wolff, Nobbe, G.Kühn, Stohmann, Wagner, Stutzer, Maercker, Hellriegel, H. Schultze, König, Dietrich, Orth, Emmerling, and Bretschneider. Among the foreign guests were Dr. Gilbert of Rothamsted, England; Professor Mayer of Wageningen, Holland; Professor Kellner of Tokio, Japan; and Professor Atwater of the United States.

The intervals between the sessions gave opportunity to visit the experiment station of the Central Agricultural Society of the Province of Saxony, Prussia, and the Agricultural Institute of the University, with its laboratory of vegetable physiology and experiment station (*Versuchsanstalt*). The station of the provincial society, commonly known as the Halle Experiment Station, has no official connection with the institute or its station, although Professor Maercker, the director of the Halle Station, is professor in the institute. The experimental work of the institute is largely in the study of diseases of plants.

One day of the session was devoted to the meetings of the Association of Experiment Stations in the German Empire (*Verband landwirthschaftlicher Versuchs-Stationen im deutschen Reiche*). (See Experiment Station Record, vol. I, page 175.) This Association is similar in purpose, organization, and operations to the American Association of Official Agricultural Chemists. It differs from that, however, in that it concerns itself more with the ways of introducing and executing the control of the commercial products investigated. The difference is explained by the fact that a large number of stations are engaged in this control, and that it is exercised almost exclusively by them, while in the United States but few stations perform such work, much of it being done by State boards, commissioners, and inspectors. It is an especial object of this Association (of which 44 of the German stations are members) to secure uniformity of methods of investigation, and efficiency in the control of fertilizers, feeding stuffs, and seeds. Comparatively little time was given to the discussion of methods of analysis at the Halle meeting, as other important matters, especially in connection with the conditions under which analyses of fertilizers should be made, called for detailed consideration.

In the meetings of the Section of Agricultural Chemistry a considerable number of papers and informal reports were presented and discussed.

The Dresden Experiment Station for Plant Culture, established April 1, 1890, by the Saxon Government, and located in the Dresden Royal Botanic Garden, was described by Professor Drude, director of the Botanic Garden and superintendent of the horticultural division of the station, and Dr. Steglich, superintendent of the agricultural division of the station. The description was of special interest as illustrating the ways in which the managers, with the advantage of the latest and best experience, have planned the appliances and work of the station. Unlike the majority of the German stations, this is supported and controlled entirely by the Government. It has the same governing board as the station at Tharand. As that station, of which Professor Nobbe is director, was not provided with the desired land for garden and field experiments, and the Dresden Botanic Garden as newly organized included ample ground, an area of about 8.75 acres (3.5 hectares) was assigned to the new station. Buildings, including botanical and chemical laboratories, are being erected. An area of 2.8 acres (1.12 hectares) has been laid out in plats for experiments on varieties, effects of fertilizers, and diseases of plants and their prevention. One peculiar feature of the plat experiments is the plan for tests with typical soils of Saxony. For this purpose the soil of a measured area is removed to the depth of one meter and replaced by the special soils for experiment, which are brought from appropriate localities. An apparently uniform sandy or gravelly subsoil is thought to promise uniform drainage and water supply from below. While these experiments are being made at the

station, others on similar small plats are to be carried out in accordance with the same schedules by farmers in different parts of Saxony under the direction of the station. Experiments in which the effects of fertilizers and kindred questions are to be studied under circumstances which provide for uniformity of soil, regulation of moisture, collecting of all drainage water for analysis, determination of meteorological conditions, and physical and chemical study of the soil, and of course accurate measurement and other desired examinations of the produce, are also to be made in boxes of one cubic meter content. These are made of cement, lined with glass, the joints of which are closed with red lead, and are furnished with tubes at the bottom by which water may be supplied or removed, and the water table kept at any desired level.* These boxes are surrounded by soil of the same character as that contained in them, in order to make the temperature correspond with that of the soil in its natural condition. Deep passageways between the rows of boxes make the management of the drainage tubes easy. Long thermometers running horizontally at different depths through the side of a similarly situated box of soil, serve for observations of soil temperatures.

Dr. Wohltmann of the Agricultural Institute of the University of Halle described a series of experiments conducted by himself and Dr. Scheffler during 3 successive years in boxes somewhat similar to those above described. The object was to study the effects of fertilizers containing nitrogen, phosphoric acid, and potash, singly and in combination, upon the growth of different plants, and the gain and loss of plant food by the soil under conditions at once normal and capable of measurement and control. The paper was an abstract of a memoir just published,† and not only gave the plan and results of the experiments, but discussed the experimental method, which is a modification of that proposed by Prof. P. Wagner. Summaries of this and other papers presented at the meeting will be published in the Experiment Station Record.

Dr. Gerlach of the Halle Experiment Station described several sets of experiments which were instituted as part of a series, the object of which is to work out a laboratory method for determining the deficiencies of soils in plant food. Attention was first given to phosphoric acid. In these experiments the effort is being made to find a solvent which will extract from the phosphoric acid of different soils quantities similar to those which plants can utilize and thus afford an approximate measure of the available as distinguished from the total amount of

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*In visiting this station in company with the writer, Dr. Gilbert of Rothamsted referred to the difficulty experienced there in getting boxes which will not leak, and in filling them satisfactorily with earth. After trials with different materials glazed earthenware was finally decided upon.

†Berichte a. d. physiol. Laboratorium und d. Versuchsanstalt d. Landw. Instituts d. Univ. Halle, 8, 1891.

phosphoric acid in the soil thus treated. Plants were grown in cylindrical pots (Wagner's) containing samples of the soils to be studied. The effect of phosphatic fertilizers, as measured by the increase of yield when they were applied, was compared with the amounts of phosphoric acid extracted by acetic, tartaric, oxalic, and citric acids and their salts. From several hundred experiments which have been conducted during 2 years with some sixteen typical soils, it appears that a 1 per cent solution of citric acid generally serves to indicate the amount of phosphoric acid available to plants. There are, however, exceptions which are not yet explained. In the course of the discussion of the paper, Professor Orth of Berlin, whose studies of soils are well known, remarked upon the need of detailed study of the physical and geological characters of the soil, and of the physiological habits of the plants as well. It was explained both by Dr. Gerlach and by Professor Maercker that the results thus far obtained are regarded as tentative, and no final conclusions are yet made. They hope, however, by their studies, which embrace not only the geological, physical, and chemical characters of the soils, but also their agricultural characters as shown by past and present experience and experiment, to work out a reliable method for such soil analysis as they are now attempting. They contemplate extending the inquiry to other soil elements of plant food, as potash and nitrogen. Incidentally Professor Maercker stated that the Wagner method of pot culture had proven very satisfactory. Parallel experiments had been made in ordinary earthen pots with results which agreed in the main with those obtained in the Wagner cylinders.

Another line of study with reference to the needs of soils and the feeding capacities of plants, namely, the growing of plants with different fertilizers and analyzing the produce, was presented in a paper by Professor Liebscher of the Agricultural Institute of the University of Göttingen. This gave the results of a series of experiments which have been in operation for several years in the experimental garden of the institute. Different plats of land were treated with nitrogen, phosphoric acid, and potash compounds, singly, two by two, and all three together. In the crops which grew upon them the quantities of the same elements were determined. Although the results thus far obtained do not warrant broad generalizations, Professor Liebscher hoped that such would be obtainable by further prosecution of the inquiry.

Professor Hellriegel addressed the meeting upon quantitative vegetation experiments and individual factors of growth. He laid special stress upon the importance of having the conditions of experiment under control, and so regulating them that while the particular factor in question should be adapted to the purpose of the experiment, all the others should be favorable. In this way and in this way alone can exact studies of the effects of individual factors be made. He dwelt

upon the errors and evils which result from neglect to observe this principle, and at the same time pointed out the great difficulties in observing it properly. He also urged the danger of hasty inferences and the need of repeating experiments.

Dr. Morgen of the Halle Station cited the results of extended experience and experiment in the detection of adulterants, especially Redonda phosphate, in Thomas slag. The determination of loss on ignition is often helpful, a loss of 0.5 to 1 per cent indicating adulteration. The specific gravity method of Loges is also valuable, but instead of potassio-mercuric iodide solution for detecting Redonda phosphate, Dr. Morgen recommended bromoform (sp. gr. 2.9). The method of Richter for separating Redonda phosphate from Thomas slag by dilute soda solution is excellent. Five per cent solution of citric acid dissolves Thomas slag, but not Redonda phosphate. The method of Jantsch and Schucht is one of the best for quantitative determinations of Thomas slag.

Dr. Cluss of the Halle Station cited some interesting experiments on the use of hydrofluoric acid as an antiseptic in the manufacture of alcohol. It prevents souring and promotes the fermentative action of yeast in a very marked degree.

Dr. Wilfarth of the station at Bernburg described a germination apparatus for testing seeds, especially of sugar beets. It consisted of a brass sieve, the bottom of which was covered with muslin. On this were placed the seeds and over them another piece of muslin was laid. This latter was covered by a layer of sand, which was kept moist.

Professor Drude of Dresden and others gave the results of experience with fungicides on potatoes affected by *Peronospora viticola.*

A paper which excited especial interest was one by Dr. Gilbert on root tubercles and the fixation of atmospheric nitrogen by plants. It was a preliminary notice of methods and results of a large number of experiments at Rothamsted with annual and perennial legumes grown in sterilized sand and in rich soil, without nitrogenous fertilizers, and with and without inoculation by microbe seeding. A number of photographs showed the development of the plants and of the root tubercles. The inoculated plants had abundant root tubercles, grew vigorously without nitrogenous fertilizers, and gained large quantities of atmospheric nitrogen. The connection between this acquisition and the root tubercles was perfectly evident, thus confirming observations of other experimenters. Especial attention was called to the development of root tubercles at different periods of growth of the plants and to marked differences between the annuals and perennials. The author has furnished an abstract for the Experiment Station Record.

In the discussion which followed the reading of Dr. Gilbert's paper, Professor Hellriegel, who was the first to show the connection between the root tubercles and the fixation of nitrogen and whose results it was one purpose of Messrs. Lawes and Gilbert's experiments to confirm,

cited some of his own observations on the root tubercles, and urged that a great deal of experimental study would be needed before their nature and action would be fully understood. To illustrate the practical applications to be made of the information already gained, he cited some instances of notable increase of leguminous crops, which had been effected by spreading sand or other soil from fields where legumes had flourished in small quantities over ground where the same legumes were to be grown. This is simply a practical application of the methods of inoculating the roots with tubercle microbes, which have brought such remarkable results in experiments on a small scale. Science has thus far taught that the chief uses of tillage and manuring are to regulate the moisture and temperature of the soil and to provide proper food for the plants grown upon it. This reveals another means for increasing the growth of our crops, namely, the furnishing of bacteria to enable the plants to provide themselves with nitrogen from the air.

By request, Professor Atwater of this Office gave an account of the agricultural experiment station enterprise in the United States.—[W. O. A.]

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Connecticut State Station, Bulletin No. 109, August, 1891 (pp. 40).

FERTILIZERS.—Tabulated analyses are given of 57 samples of nitrogenous superphosphates and 38 samples of special manures collected during the present year, and of 19 home mixtures.

Of the 57 brands [of nitrogenous superphosphates] here reported, 14 are below their minimum guaranty in respect of one ingredient, and 6 in respect of two ingredients. That is, one third of all the nitrogenous superphosphates in our market contain less of one or of several ingredients than they are claimed to contain. * * *

[Of the 38 special manures] 11 brands are below the maker's guaranty in respect of one ingredient, 2 in respect of two ingredients, and 1 brand is below in all three. * * * A comparison of the average composition of these special manures with that of the other nitrogenous superphosphates shows the former to contain on the whole considerably more nitrogen, nearly twice as much potash, and somewhat less phosphoric acid than the latter. * * *

Comparing the home mixtures with the special manures it is seen that the former contain on the average (14 analyses) half of 1 per cent more nitrogen, over 1.5 per cent more phosphoric acid, and slightly more potash than the latter.

The average cost of the materials of which these mixtures were made, delivered, was $34.82. To this must be added the cost of screening and mixing. * * * If the average cost of the mixed materials is placed at $37 per ton it will probably fully cover all expense in every case.

On this basis of averages the home mixtures, containing considerably more of both nitrogen and phosphoric acid and slightly more potash than the special manures, have cost $37 per ton, or 6.2 per cent more than the station's valuation of the ingredients; the special manures have cost $38.70, or 23.7 per cent more than the station's valuation; and the nitrogenous superphosphates, which contained considerably less nitrogen and about half as much potash but somewhat more phosphoric acid than the special manures, have cost $33.97, or 26.7 per cent more than the station's valuation.

Connecticut Storrs Station, Bulletin No. 7, September, 1891 (pp. 16).

CHEMISTRY AND ECONOMY OF FOOD, W. O. ATWATER, PH. D., AND C. D. WOODS, B. S.—This is a brief résumé of the results of inquiries carried on by the authors for a number of years. Detailed accounts of these investigations will be published in the Annual Report of the station for 1891. Besides general explanations regarding the chemical composition and digestibility of foods, and the principles of food economy, the bulletin contains seven tables with data as follows:

(1) Percentages of nutrients, water, and refuse, and estimated potential energy in specimens of food materials (animal and vegetable) as purchased; (2) percentages of nutrients, water, etc., and estimated potential energy in the edible portion of specimens of food materials; (3) digestibility of nutrients of food materials; (4) proportions of nutrients digested and not digested from food materials by healthy men; (5) standards for daily dietaries for people of different classes; (6) nutrients and potential energy in dietaries of different people; (7) amounts of nutrients furnished for 25 cents in food materials at ordinary prices. The potential energy of the nutrients is estimated in Calories. "The chemical composition of foods is compiled from American analyses, the digestion experiments are wholly European, and the dietaries are both American and European. * * * Not far from fifty dietaries of several hundred people in private families and boarding houses, mostly in New England, have been collated, and the chemical analyses of quite a large number of animal foods—meat, fish, oysters, and the like—have been made in the chemical laboratory of Wesleyan University and by this station since 1880."

Standard vs. actual daily dietaries for people of different classes.

[100 grams = 3.5 ounces or 0.22 pounds. 1 ounce = 28.35 grams. 1 pound = 453.6 grams.]

	Nutrients.				Potential energy of nutrients.
	Protein.	Fat.	Carbohydrates.	Total.	
Standards for daily dietaries.					
Voit *et al*:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Cal.*
Children, 1 to 2 years (German)	28	37	75	140	765
Children, 2 to 6 years (German)	55	40	200	295	1,420
Children, 6 to 15 years (German)	75	43	325	443	2,040
Aged woman (German)	80	50	260	390	1,860
Aged man (German)	100	68	350	518	2,475
Woman at moderate work (German)	92	44	400	536	2,425
Man at moderate work (German)	118	56	500	674	3,055
Man at hard work (German)	145	100	450	695	3,370
Playfair:					
Man with moderate exercise (English)	119	51	531	701	3,140
Active laborer (Eglish)	156	71	568	795	3,630
Laborer at hard work (English)	185	71	568	824	3,750
Atwater:					
Woman with light exercise (American)	80	80	300	460	2,300
Man with light exercise (American)	100	100	360	560	2,815
Man at moderate work (American)	125	125	450	700	3,520
Man at hard work (American)	150	150	500	800	4,060
Actual dietaries in United States and Canada.					
French-Canadian working people in Canada	109	109	527	745	3,620
French-Canadians, factory operatives, in Massachusetts	118	204	549	871	4,630
Other factory operatives, mechanics, etc., in Massachusetts	127	186	531	844	4,430
Glass blowers, East Cambridge, Massachusetts	95	132	481	708	3,590
Factory operatives, boarding house, Massachusetts	114	150	522	786	4,000
Well-to-do private family, Connecticut: food purchased	129	183	467	779	4,145
Well-to-do private family, Connecticut: food eaten	128	177	466	771	4,080
College students from Northern and Eastern States, boarding club, two dietaries, same club: food purchased	161	204	680	1,045	5,345
food eaten	138	184	622	944	4,825
food purchased	115	163	460	738	3,875
food eaten	104	136	421	661	3,415
College football team, food eaten	181	292	557	1,030	5,740
Mechanics (machinists), Connecticut	105	147	399	651	3,435
Machinist, Boston, Massachusetts	182	254	617	1,053	5,640
Teamsters, marble workers, etc., at hard work, Massachusetts	254	363	826	1,443	7,805
Brickmakers, Massachusetts	180	365	1,150	1,695	8,850
U. S. Army ration	120	161	454	735	3,850
U. S. Navy ration	143	184	520	847	5,000

Illinois Station, Bulletin No. 17, August, 1891 (pp. 16).

EXPERIMENTS WITH WHEAT, 1890–91, G. E. MORROW, M. A. (pp. 1–9).—A record of experiments in continuation of those of previous years, reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 273). The topics treated are (1) quantity of seed, (2) time of sowing, (3) depth of sowing, (4) effect of fertilizers, (5) test of varieties. With the exception of some of the fertilizer tests, the experiments were made on the fertile, dark-colored prairie soil of the station farm. The season was unusually favorable for wheat.

Wheat, quantity of seed.—Notes and tabulated data are given for an experiment on seven plats, 2 by 4 rods each, seeded at the rate of from 3 to 8 pecks per acre.

Trials for 3 years indicate that variations in quantity of seed between 1 and 2 bushels per acre have less effect on yield than other conditions have. In 1891 the largest yield was from 6 pecks per acre; in 1890, from 4 and from 8 pecks; in 1889, from 5 pecks.

In 1891 sowing small kernels gave a larger yield than was obtained from the same weight of larger kernels, but less than from the same number of larger kernels. The kernels in the crop from the small seed were approximately as large as those from the larger seed.

In two trials no injury resulted from rolling drilled wheat soon after sowing.

Wheat, time of sowing.

The yields of five plats, sown at intervals of 10 or 12 days from September 2 to October 14, were all good [30.8–36.4 bushels per acre]. It is not certain that they were affected by the date of sowing. If the last-sown plats be excepted, there was no appreciable difference in time of ripening, and very little including it. The quantity of straw and the number of stalks per square foot decreased from the earliest to the latest sowing. The average length of heads and weight of kernels increased from the first to the last, except in the case of the second sowing, which was better than the third. In view of danger from the Hessian fly and of undue growth of straw, very early sowing is not advisable; and the danger to late-sown wheat from repeated freezing in winter or early spring makes it unsafe in this latitude to sow in October.

Wheat, depth of sowing.—"September 27, 1890, in each of nine rows 1 rod long and 1 foot apart, 198 kernels of selected seed wheat were planted. This is one kernel for each inch." In each plat of three rows the wheat was covered 1 inch, 3 inches, or 5 inches. The yields diminished with the increased depth of planting.

Wheat, effect of fertilizers.—Notes and tabulated data are given for experiments with commercial fertilizers and barnyard manure at the station and in four other localities in Illinois. At the station the yields where commercial fertilizers were used and the yields in 1891 on plats where commercial fertilizers had been applied in large amounts in 1889, averaged somewhat less than those on unfertilized plats. The results of all the trials with commercial fertilizers on wheat at the station indicate that such fertilizers are not profitable on the black prairie soils of central Illinois.

Trials at Flora, Odin, and Nashville show a marked increase in yield from use of barnyard manure; those at Odin and Nashville, some increase from the use of superphosphate of lime, but in general not enough to make its use profitable. At Belleville neither barnyard manure nor superphosphate produced any considerable percentage of increase in yield. At Flora the plats with superphosphate yielded less than those without any fertilizer. In view of the results in former years, trials on a small scale with superphosphate of lime and cattle tankage are recommended for wheat on the light-colored soils of southern Illinois. The value of barnyard manure for these soils can hardly be overestimated.

Wheat, test of varieties.—A brief report is given on tests of 12 varieties of English cross-bred wheat and of 2 varieties from France. The indications were that with perhaps two or three exceptions these varieties would mature too late to be desirable for Illinois. Campbell's White Chaff wheat, a spring variety from Canada, did not give promising results at the station.

DAILY VARIATIONS IN THE MILK AND BUTTER PRODUCTION OF COWS, E. H. FARRINGTON, M. S. (pp. 9–16).—Diagrams are given which graphically represent the variations in the yield of milk and in percentage and amount of butter fat from day to day for each of two cows, the variations in the night's and morning's milk of one cow, and the daily variations in the mixed milk of three cows for periods of from 40 to 66 days, together with the daily variations in temperature. These diagrams show for the cows under trial, the food and general conditions remaining constant, that, (1) there were usually very considerable changes in the yield of milk of the individual cows, and the percentage of butter fat in the same from day to day; (2) cows receiving the same food differed from each other as to the amount of this variation; (3) the variations from day to day in the morning's and evening's milk considered separately were greater than in the mixed milk for the day; (4) the mixed milk of several cows was more uniform in amount and in quality than the milk of individual cows; and (5) "as a rule the number of pounds of milk was low when the mean daily temperature was high and the number was high when the temperature was low." It was noticed in the case of one cow that "when she gave a small mess of milk it had a per cent of butter fat below her average, and the largest milkings were of her richest milk." The maximum, minimum, and average daily yields of milk and of butter fat from May 1 to August 1 are also tabulated for each of six cows.

Iowa Station, Bulletin No. 13. May, 1891 (pp. 120).

EXPERIMENT IN FEEDING FOR MILK, J. WILSON, G. E. PATRICK, M. S., C. F. CURTISS, B. S. A., E. N. EATON, B. S., AND D. A. KENT, B. S. (pp. 5–30).—This trial was made with eight cows and was designed to test the relative feeding value of corn fodder, corn silage, sorghum silage, and mangel-wurzels. Each of these coarse fodders was fed during a period of 10 days, the intervening transition periods being

5 days each. The silage and corn fodder were fed *ad libitum*, from 40 to 45 pounds of roots were fed per animal, the grain rations were different for each cow, and clover hay was fed with each of the coarse fodders in varying amounts. Data as to the amount of each food consumed and the yield and composition of the milk are tabulated for each cow, and summaries are given for the eight cows on each coarse fodder. In the case of four of the cows the production of milk and of butter fat was largest when roots were fed; two others gave the largest yield with corn fodder, and two with corn silage. About twice as much clover hay was fed with the roots, however, as with either of the other coarse fodders. It is obviously impossible to gain an idea of the real effect of the different coarse fodders. The financial side of the question is not considered and the cost of the different feeding stuffs is not given.

TREATMENT OF FUNGOUS DISEASES, L. H. PAMMEL, B. AGR. (pp. 31–71, plates 10, figs. 16).—General explanations of fungous diseases of plants and their treatment, formulas for various copper solutions, descriptions of spraying apparatus, and original and compiled notes on the nature and treatment of apple rust (*Rœstelia pirata*), pear leaf blight (*Entomosporium maculatum*), plum rust (*Puccinia pruni-spinosæ*), spot diseases of currants (*Septoria ribis* and *Cercospora angulata*), spot disease of the cherry (*Cylindrosporium padi*), apple scab (*Fusicladium dendriticum*), strawberry leaf blight (*Sphærella fragariæ*), potato rot (*Phytophthora infestans*), and clover rust (*Uromyces trifolii*).

Apple rust.—Spraying with Bordeaux mixture and ammoniacal carbonate of copper on two trees did not prevent the appearance of the fungus in abundance.

Spot diseases of currants.—Bordeaux mixture and ammoniacal carbonate of copper sprayed on the Blue Naples and White Dutch currants, largely prevented injury from spot diseases.

Spot diseases of the cherry.—Ammoniacal carbonate of copper alone or following Bordeaux mixture was successfully used for this disease in several experiments.

Clover rust.—This disease was first observed in the rowen of red clover in August, 1890. "Later it was found quite abundant on the campus and college farm. So severely did it attack some of the plants, especially the stem and leaves, that in touching the plants the hands became covered with brown spores."

WEED PESTS, L. H. PAMMEL, B. AGR. (pp. 72–75).—Brief notes on ox-eye daisy (*Chrysanthemum Leucanthemum*), hawkweed (*Hieracium aurantiacum*), Canada thistle (*Cnicus arvensis*), horse nettle or sand briar (*Solanum carolinense*), spiny nightshade (*Solanum rostratum*), and dodder (*Cuscuta trifolii*) with a view to putting Iowa farmers on their guard against these pests.

PRELIMINARY REPORT ON THE EXAMINATION OF SOME SEEDS, P. H. ROLFS, B. S. (pp. 75–86, figs. 7).—An examination of the seeds of a number of species of clovers and grasses purchased by the station,

revealed the presence of sand, mixed grasses, and numerous weeds in considerable quantities.

NOTES ON METHODS OF CROSS-POLLINATION, F. A. SIRRINE (pp. 87-92).—Two methods of castrating the flowers of the plum were tried at the station in 1890, as follows:

"(1) Careful opening of the buds and picking out the stamens with a fine pair of tweezers. This was a very tedious way, but the petals helped to protect the tender style and stigma. (2) The cutting or tearing off of the whole calyx which bears the petals and stamens, leaving the ovary unprotected. This was done by taking the base of the bud between the prongs of the tweezers, simply holding the bud sufficiently close but not pinching it, then by giving the tweezers an upward jerk the part of the calyx which bears the stamens will be removed."

The same methods were used on the cherry, and the second method, with slight variations, on the apple and rose.

Successful crosses were obtained by using the pollen of Kentucky blue grass on the female plant of Texas blue grass. "In a white sport of red clover artificial pollination was tried with its own pollen, but seed was not produced." From planting corn in an isolated part of the field, removing the tassels, and hand-pollinating the ears without covering better results were obtained than from covering the corn with sacks. Before sunrise was found to be the best time for applying the pollen.

NOTES ON INSECTS, H. OSBORN, M. S., AND H. A. GOSSARD, B. S. (pp. 95-115, plate 1, figs. 10).—General statements regarding the injuries to meadows and pastures by insects, with suggestions as to means for their repression; notes on the tenderfoot leaf hopper (*Diedrocephala mollipes*), hurtful leaf hopper (*Deltacephalus inimicus*), *D. debilis*, destructive leaf hopper (*Cicadula exitiosa*), clover seed midge (*Cecidomyia leguminicola*), horn fly (*Hæmatobia serrata*), and apple maggot (*Trypeta pomonella*); and directions for spraying orchards. The four figures illustrating the notes on the first four insects named above are original.

BLOSSOMS OF ORCHARD FRUITS, J. L. BUDD, M. H. (pp. 115-118).—"The observations of the past 30 years on the prairies west of Lake Michigan sustain the proposition that the varieties of orchard fruits vary in hardiness of fruit buds and blossoms quite as much as they do in relative hardiness of tree. The proposition can also be sustained that the typical ironclad tree has hardier fruit buds and blossoms than the one that poorly withstands our trying changes of summer and winter." This is illustrated by references to a number of varieties of apples, cherries, plums, and pears. Attention is called to the fact that some of the Silesian and South Russian cherries have an additional provision for escaping untimely frosts in bearing two distinct sets of blossoms, one of which opens later than the other. In view of the accumulating evidence that fruit trees are not likely to be self-fertilized, the author advises the alternating of varieties in the rows of orchards, with special attention to differences in the time of blooming.

SOME OBSERVATIONS ON CONTAMINATED WATER SUPPLY FOR LIVE STOCK, M. STALKER, V. S. (pp. 118–120).—Observations by the author on sickness among farm animals caused by drinking impure water are cited to enforce the desirability of attention to this matter on the part of farmers.

Iowa Station, Bulletin No. 14, August, 1891 (pp. 73).

EFFECT OF FOOD UPON QUALITY OF MILK, J. WILSON, D. A. KENT, B. S., C. F. CURTISS, B. S. A., AND G. E. PATRICK, M. S. (pp. 123–142).—In this experiment as to the effect of rations containing different amounts of protein, fat, and carbohydrates on the composition of the milk, four cows were used, three being grade Shorthorns, and the other a grade Holstein, all of which had calved within from 14 to 44 days previous to the experiment. The difference in the relative amounts of nutrients was brought about by feeding corn-and-cob meal containing 3.24 per cent crude fat, 9.66 per cent crude protein, and 76.17 per cent carbohydrates (exclusive of cellulose) in the dry matter, *vs.* gluten meal containing 11.88 per cent fat, 21.58 per cent protein, and 56.08 per cent carbohydrates in the dry matter, the coarse fodder being the same in kind and amount at all times (12 pounds corn fodder and 4 pounds clover hay per animal daily). The experiment extended from March 22 to June 9, and included three 21-day periods, separated by transition periods of 10 days each.

Cows Nos. 21 and 22 each received daily in addition to the coarse fodder, 12¼ pounds of corn-and-cob meal in the first period, 10 pounds of gluten meal in the second period, and 13 pounds of corn-and-cob meal in the third period. The order was reversed in the case of cows 33 and 65, 10 pounds of gluten meal per animal being fed in the first and third periods, and 12¼ pounds of corn-and-cob meal in the second period. The uneaten coarse fodder was weighed back, but all except the corn fodder, a small quantity of which was left, was eaten clean, without regard to the kind of grain fed. The milk of each cow was sampled every morning and evening, the samples being preserved for from 4 to 7 days and the solids determined in the composite samples at the end of that time by a gravimetric method, and the fat by the Babcock centrifugal method. The analyses of the milk, therefore, represent the average composition of the milk of each milking during the entire period instead of the composition on any particular day.

The analyses of the corn-and-cob meal, the gluten meal, and the milk, and statements as to the total amounts of food consumed, the total yield of milk, of solids, and of butter fat, and the pounds of fat per 1,000 pounds of solids-not-fat, are tabulated for each animal in each period. From these data the total amounts of nutrients in the grain rations consumed during each period (the only variable food) have been calculated for each animal, and these, together with the total yields of milk and of fat during each period and the average composition of the milk, are given in the following table:

Record of each animal per period.

Period.	Grain ration of cows Nos. 21 and 22.	In grain. Crude fat.	In grain. Crude protein.	In grain. Carbohydrates.*	Cow No. 21. Yield of milk.	Cow No. 21. Total solids.	Cow No. 21. Fat.	Cow No. 21. Solids-not-fat.	Cow No. 21. Amount of fat.	Cow No. 22. Yield of milk.	Cow No. 22. Total solids.	Cow No. 22. Fat.	Cow No. 22. Solids-not fat.	Cow No. 22. Amount of fat.
		Pounds	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent*	*Pounds.*
1	Corn and cob meal	7.23	21.53	169.76	641.25	11.57	3.43	8.14	21.67	604.75	11.85	[illegible]	[illegible]	21.56
2	Gluten meal	23.44	42.57	110.59	641.50	12.53	4.04	8.49	25.93	582.00	12.37	3.91	8.46	22.74
3	Corn and cob meal	7.67	22.85	180.15	559.00	11.86	3.22	8.64	17.97	527.00	12.05	3.37	8.68	17.78

Period.	Grain ration of cows Nos. 33 and 65.	In grain. Crude fat	In grain. Crude protein	In grain. Carbohydrates	Cow No. 33. Yield of milk	Cow No. 33. Total solids.	Cow No. 33. Fat.	Cow No. 33. Solids-not fat	Cow No. 33. Amount of fat.	Cow No. 65. Yield of milk.	Cow No. 65. Total solids.	Cow No. 65. Fat.	Cow No. 65. Solids-not fat.	Cow No. 65. Amount of fat.
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Per cent*	*Per cent*	*Per cent.*	*Pounds.*	*Pounds*	*Per cent.*	*Per cent.*	*Per cent*	*Pounds*
1	Gluten meal	23.44	42.57	110.59	753.5	12.43	3.97	8.46	29.94	487.5	13.27	4.15	9.12	20.25
2	Corn and cob meal	7.23	21.53	169.76	601.5	11.45	3.15	8.30	18.97	379.0	12.69	3.51	9.18	13.30
3	Gluten meal	23.44	42.57	110.59	560.5	12.16	3.85	8.31	21.58	374.5	13.01	3.72	9.29	13.95

*Exclusive of cellulose.

The foregoing table shows that when the gluten meal, containing larger amounts of protein and fat, was fed there was an increase both in the percentage of total solids and fat and in the total amount of fat produced during the period in the case of every cow. While there were slight changes in the percentage of solids-not-fat, these changes seemed to be independent of the food, for in the case of every cow except No. 33 there was a steady increase in the percentage of solids-not-fat from the beginning to the close of the experiment regardless of the changes made in the grain food. The proportion of the fat to the solids-not-fat was noticeably larger with gluten meal. This would seem to be a case of a one-sided increase of the fat, such as has been previously noticed in a few isolated cases only. The increase in the percentage of fat when the cows were changed from the corn-and-cob meal to the gluten meal amounted in some instances to 0.61 and 0.70 per cent; and when they were changed from gluten meal to corn-and-cob meal there was a decrease of from 0.54 to 0.82 per cent in the fat. The interest of the subject renders additional data for a larger number of animals very desirable.

Calf-feeding experiment, J. Wilson, C. F. Curtiss, B. S. A., D. A. Kent, B. S., and G. E. Patrick, M. S. (pp. 143–151).—A comparison of whole milk and skim milk for young calves. Four calves, two Shorthorns and two Holsteins, a bull and a heifer of each, were used for the trial. They varied in age from 33 to 64 days, and were fed from April 1 to June 30—91 days. Each day the milk from three cows was divided into two equal parts, one half being divided equally between the two bulls, and the other half set for 12 hours and then skimmed, and the skim milk fed to the two heifers. An attempt was made to make the skim-milk ration approximately equal to the whole-milk ration by adding 1.5 pounds of ground flaxseed per day to the skim milk of each animal. All of the calves received grain (a mixture of equal parts of ground oats, ground barley, corn meal, and wheat bran) and clover hay in addition to the milk. The amount of these was the same for each calf, and was increased with the growth. The rations fed and gains made during periods of 15 days, together with a summary for the 91 days' feeding, are tabulated. During the whole experiment the gains on the whole-milk ration were, Shorthorn 178 pounds and Holstein 234 pounds; and on the skim-milk ration, Shorthorn 155 pounds and Holstein 171 pounds.

The best results as to gain came from the whole milk, but taking all things into consideration we regard the outcome of the experiment as quite favorable to the skim milk and flaxseed ration. If the calves were to be judged by their condition as to thrift and general appearance, omitting the test of the scales, the verdict would be in favor of the skim milk and flaxseed. * * * Heredity may or may not have figured in the results, but if it did it was against the skim-milk ration. Both skim-milk calves were in better condition than either of the others. At the end of the experiment the milk was taken away from all of the calves and they were put on pasture and equal grain rations. Here again the results were in favor of the skim-milk calves. * * *

The cost of producing a pound of gain (estimating new milk at 87½ cents per 100 pounds, skim milk at 15 cents per 100 pounds, grain at 1 cent per pound, hay at $5 per ton, and flaxseed meal at 3½ cents per pound) was 7.6 cents for the fresh-milk ration and 5 cents for the skim-milk ration.

A FEEDING EXPERIMENT FOR MILK, J. WILSON, C. F. CURTISS, B. S. A., D. A. KENT, B. S., G. E. PATRICK, M. S., AND E. N. EATON, B. S. (pp. 152–161).—This is a record of a single cow from February 25 to June 18. In the first 2½ months of this time corn fodder, corn silage, sorghum silage, and roots were compared, feeding 20 pounds of corn-and-cob meal per day with each coarse fodder; from May 19 to June 7 half the corn-and-cob meal was replaced by 7 pounds of bran and 3 pounds of linseed meal, and fed with hay; and from June 9 to 18 this grain ration was reduced one half and fed with pasturage. The data showing the amounts of food consumed and of milk yielded, and the composition of the milk are tabulated. "The substitution of bran and oil meal for half the amount of corn meal resulted in a marked increase in both quantity and quality of milk, the increase in quality being still more than the increase in quantity."

PIG-FEEDING EXPERIMENT, J. WILSON, C. F. CURTISS, B. S. A., D. A. KENT, B. S., AND G. E. PATRICK, M. S. (pp. 162–165).—This is a record of the food consumed and the live weight gained by a sow and her litter of seven pigs for 153 days. The principal food was ear corn and shelled corn, supplemented at different times by ground barley, linseed meal, corn-and-cob meal, and bran, all of which were soaked before feeding. The sow and pigs together gained 626⅝ pounds live weight, and consumed 2,032 pounds of grain during the trial. The cost of the rations is not given.

REPORTS ON ENTOMOLOGICAL WORK, H. OSBORN, M. S., AND H. A. GOSSARD, B. S. (pp. 166–180, fig. 1).—The following summary of this article is taken from the bulletin:

The clover seed caterpillar (*Grapholitha interstinctana*), which has been abundant and destructive, is described and figured in different stages, and the conclusion reached [from observations cited] that cutting the clover and storing it while the caterpillars are still in the clover heads, results in the entire destruction of the insect.

Experiments with hopper-dozers for grass leaf hoppers show that this method can be used very successfully in capturing the insects [especially while immature]; that the simplest form (a flat sheet of sheet iron) was most satisfactory; that one application resulted in adding 34 per cent to the crop of hay on a plat experimented on, and in one experiment leaf hoppers were captured at the rate of 376,000 per acre.

Kerosene emulsion for plant lice was used once with poor success, but later an application of a good emulsion by thorough methods resulted in complete success.

Grasshoppers are mentioned as troublesome this season and the reports of Rocky Mountain grasshoppers (*Coloptenus spretus*) referred to. No present damage to Iowa is apprehended from this latter species, and methods of controlling the common native species when numerous are discussed.

The flavescent clover weevil [*Sitones flavescens*] is found abundant at Ames. Its distribution is referred to and its method of work described. Information regarding its occurrence in other parts of the State is requested.

The wheat-bulb worm [*Meromyza americana*] has occurred in moderate numbers, but abundant parasites [*Coelinius meromyzæ*, and two undetermined species] have been found to attack it at Ames, and its serious multiplication is not considered probable.

Directions for making kerosene emulsion and arsenical solutions are briefly given.

BREEDING OF ORCHARD AND GARDEN FRUITS, J. L. BUDD, M. H. (pp. 181–190).—The experience of the author and other fruit growers in Iowa and other States of the Northwest is cited in support of the following propositions:

(1) In the States west of Lake Michigan no important advances have been made in the great work of adapting fruits to our peculiar climate and soil by growing seedlings from the varieties introduced from southwest Europe, nor from their seedlings originating in the Eastern or Southern States.

(2) Our valuable seedlings of the orchard and garden fruits have come from the varieties introduced from east Europe or north Asia and from our native species.

(3) Methodic crossing and hybridizing have given in the past and promise to give in the near future more valuable and certain results than we can hope for from chance breeding from intermingled varieties and species.

Brief notes are given on the following crosses of apples made at the station during the past 4 years: *Crosses made 4 years ago.*—Silken Leaf with pollen of Osceola, Roman Stem, and Longfield; Department Cross with Osceola and Scott Winter. *Crosses made 3 years ago.*—Beautiful Sweet with Garden Apple, Ostrokoff with Ben Davis, Department Cross with Ben Davis, Antonovka with Wythe, Little Hat with Roman Stem, Anisovka with Autumn Strawberry, Pyrus Toringo with Wythe, Pyrus Ringo with Duchess. *Crosses made 2 years ago.*—Duchess with Iowa Keeper, Rawles Janet, Roman Stem, Tallman Sweet, Ben Davis, and Boone Crab; Iowa Keeper with Wythe; Wythe with Grimes Golden, Roman Stem with Wythe. The seedlings from the last three crosses are not at all promising.

AN APHTHOUS AFFECTION AMONG DAIRY COWS OF THE STATE, M. STALKER, V. S. (pp. 191–195).—A brief account of observations on a disease which has recently appeared among cattle, especially milch cows, in southeastern Iowa. The symptoms are stated and suggestions made regarding treatment. The disease seems to differ in some respects from the forms of aphtha previously described. The cause has not yet been investigated.

Kansas Station, Bulletin No. 20, July, 1891 (pp. 46).

EXPERIMENTS WITH WHEAT, C. C. GEORGESON, M. S., H. M. COTTRELL, M. S., and W. SHELTON (pp. 1–46).—These include experiments on (1) methods of seeding, (2) effects of character of seed, (3) effect of top-dressing with plaster and of spring harrowing, (4) single varieties *vs.* a mixture of varieties for seed, (5) effects of pasturing wheat, (6) continuous cropping with wheat, (7) rotation experiments, and (8) test of varieties. Accounts of previous experiments with wheat may

be found in Bulletins Nos. 7 and 11 of the station (see Experiment Station Record, vol. I, p. 214, and vol. II, p. 219).

In the first-named five lines of these experiments the plats were one-twentieth acre in extent, measuring 33 by 66 feet; with but few exceptions not less than five plats were subjected to the same treatment, and the conclusions are based on the average yield of the five. Plats thus similarly treated are not placed by the side of each other, but, as far as the formation of the land will permit, they are placed alongside of and in alternation with the plats with whose treatment or non-treatment they are to be compared. A space of 2 feet in width separates them along the sides, and at the ends a turning row of 12 feet in width separates adjoining series.

The land was believed to be quite even in fertility.

Methods of seeding (pp. 3–6).—The methods of seeding tested were (1) broadcasting, (2) by shoe drill with press wheels, (3) by shoe drill without press wheels, (4) by hoe drill, (5) by roller drill, (6) listing, and (7) cross-drilling, each of the methods being tried on five different plats. The land was a clay loam and had been used for oats in 1890. Five pecks of Zimmerman seed per acre were sown on all except the listed plats, where from 3 to 4 pecks per acre were used. The results are tabulated for each method, and a summary is given of all the trials. "Broadcasting gave the best yield of all, followed closely by the plats seeded with the roller drill. The broadcasted plats had a good stand, though not so even as the stand on the drilled plats. It is worthy of note that these same two methods of seeding, viz, the roller drill and broadcasting, gave also the best results in last year's oats experiments." The results where the shoe drill and the hoe drill were used were "practically identical." There was no perceptible advantage from cross-drilling. The lowest yield occurred where the wheat was listed. This is believed to be largely attributable to the large amount of rain.

Effects of character of seed (pp. 7–9).—The effects were studied on 18 plats of using "common," "light," "heavy," and selected seed, and seed from wheat cut while in the milk.

The common seed was the wheat as it came from the thresher—simply cleaned from chaff and straw. It weighed 63 pounds per struck bushel. The light seed was taken from the screenings obtained by running the common seed through the fanning mill, and consisted chiefly of small with some shriveled and cracked seed. It weighed 58½ pounds to the struck bushel. The heavy seed consisted of the best grade that could be gotten by running the common seed through the fanning mill. It weighed 64¼ pounds to the struck bushel.

[The yield per acre and the weight of the wheat per bushel are tabulated for each kind of seed.] Taking the common seed as the standard, which may fairly represent the character of the seed usually sown by our farmers, this experiment shows a gain in the yield by the use of better seed, whether obtained by grading it with a fanning mill or by selecting choice heads and taking the seed from them. On the contrary, a loss is entailed by the use of seed cut too early, or light and inferior seed.

Effects of top-dressing wheat with plaster and of spring harrowing (pp. 9, 10).—Brief tabulated notes on the results of applying 400 pounds of plaster per acre to wheat, and of harrowing wheat in the spring (April 12) when the plants were 8 to 10 inches high. The plaster showed "no

marked effect on the yield;" and the spring harrowing "was in this case a decided disadvantage to the crop."

Single vs. a mixture of varieties for seed (pp. 10,11).—On seven plats Zimmerman, Buckeye, and Red May varieties were sown alone and in mixtures of twos and of all three. The tabulated results show that in each case the yield where two varieties were mixed was larger than the average yield of the same two varieties when used alone. Thus when Zimmerman and Buckeye were sown singly the average yield was 38.41 bushels, but when a mixture of the two was used the yield was 43 bushels per acre, etc. The lowest yield (39.33 bushels) was where a mixture of the three varieties was sown, being lower than the average of these three varieties when sown singly.

Effects of pasturing wheat (pp. 11, 12).—Trials of wheat sown September 15, on fifteen plats, on five of which cows were pastured in October and November, and on five others in April, showed an average gain of 1.5 bushels of wheat per acre on the five plats not pastured over those pastured. "Whether the food obtained by pasturing will equal the value represented by this difference in yield, can not be determined on so small a scale. This pasturing of wheat is an important practical question. Many farmers place no small dependence on the food that their wheat fields furnish in fall and spring, and cattle will occasionally even run on the wheat all winter." It is suggested that a wet clay soil would be more liable to injury from this practice than a dry one.

Continuous cropping with wheat (pp. 12, 13).—The yields of wheat on an acre of medium heavy loam land without manure of any kind, are tabulated for each year since 1880, when the experiment was commenced. Excluding 2 years when the crop was winter-killed, the average yield per year has been 29.27 bushels. The yield in 1891 was 30.75 bushels.

Rotation experiments (pp. 13–19).—The plan is given at considerable length of two series of experiments in rotation, "with wheat as the basis, with a view to ascertain what system of cropping will yield the best returns." The yield of wheat for 1891 is tabulated. As this is the first year's crop of one series and the second of the other, no special interest attaches to the results as yet.

Test of varieties (pp. 19–46).—Data are given for 240 varieties of wheat tested at the station during the past year. Arrangements have been made by which photographs of the heads of the varieties tested will be furnished to all who may desire them, at a cost of $2.50 for the entire set.

Kansas Station, Bulletin No. 21, August, 1891 (pp. 28).

SECOND REPORT ON FUNGICIDES FOR STINKING SMUT OF WHEAT, W. A. KELLERMAN, PH. D. (pp. 47–72, plate 1).—An account of experiments with fungicides for stinking smut of wheat (*Tilletia fœtens* and

T. tritici) in continuation of those reported in Bulletin No. 12 of the Station (see Experiment Station Record, vol. II, p. 220). Reference is also made to experiments on oat smut, reported in Bulletins Nos. 8 and 15 and the Annual Report of the station for 1889 (see Experiment Station Record, vol. I, p. 216, and vol. II, pp. 340 and 638). The bulletin is illustrated with a plate showing smutted and sound heads of wheat. The land used for the experiments reported in this bulletin was upland soil used the previous season in experiments on oat smut.

The seed used was artificially smutted. It was placed in a box and a large quantity of more or less broken smutted grain added, and the whole was thoroughly stirred with hoe and shovel till the grains were black with smut. Without further preparation this was used for the alternate untreated plats. * * The variation in amount of smut on these plats was enormous, and the reason for it is not fully known; yet the fact that all the untreated plats were planted with the drill successively may account for at least some of the variation, since the smutted grains are of much less specific gravity than the sound ones, and would be sown in greater abundance the nearer the seed box was empty.

Different methods for treating the smut were tried on 93 plats, each containing 0.04 of an acre; the alternate plats remained untreated. Bordeaux mixture, eau celeste, copper sulphate, copper acetate, copper nitrate, copper chloride, murcuric chloride, potassium bichromate, and "Ward's Seed Manure" were used in different forms and applied, with one exception, during 24 hours. Hot water at temperatures varying from 138° to 127° F. was also used, the seed being dipped from 5 to 15 minutes, and cooled in water at ordinary summer temperature, in an ice-salt mixture or in 10 per cent $CuSO_4$ solution. The results as indiindicated by the yields of smutted and sound grain on both the treated and untreated plats, are stated in a table, and those on a number of plats are illustrated by diagrams. The following treatments destroyed all the smut and gave a yield of grain greater than the average of the two adjacent untreated plats: Copper sulphate 0.5, or 1 per cent solution, 24 hours, or 0.5 per cent solution 12 hours, limed; copper acetate 0.5 per cent solution, 24 hours; copper nitrate 0.5 per cent solution, 24 hours; hot water 137°, 136°, or 131° F., 5 minutes, cooled in water of ordinary summer temperature; 136°, 135°, or 128° F., 10 minutes, cooled; 129° F., 15 minutes, cooled; 130°, 129°, 128°, or 127° F., 10 minutes, cooled in 10 per cent solution $CuSO_4$. In a considerable number of cases the yield on the treated plats was much greater than would be expected by merely replacing the smutted heads by sound ones. Whether this extra increase is due to an increase in the percentage of seeds germinating or to an increased vigor of the plants from the treated seed, has not been determined.

In general the results of the experiments reported in this bulletin confirm the conclusions drawn from previous experiments.

The stinking smut of wheat is effectually prevented by treating the seed with water at a temperature of 131° F., 15 minutes. For cheapness as well as for greater efficiency (without injury to seed), this is recommended over all other

fungicides. Not only is the yield increased by an amount equal to the portion destroyed by smut but in nearly all cases there is an extra increase, usually much beyond this amount.

Kentucky Station, Bulletin No. 34, August, 1891 (pp. 23).

COMMERCIAL FERTILIZERS, M. A. SCOVELL, M. S.—A popular discussion on fertilizers and their use; analyses of 67 samples of commercial fertilizers, including bone, offered for sale in the State during 1891; and the schedule of trade values of fertilizing ingredients.

Kentucky Station, Bulletin No. 35, September, 1891 (pp. 16).

EXPERIMENTS WITH WHEAT, M. A. SCOVELL, M. S., AND C. L. CURTIS (pp. 3–14).—This is a report of the third year of experiments with wheat, the same soil (a blue grass soil) being used as in the previous experiments. The experiments of previous years were reported in Bulletins Nos. 21 and 30 of the station (see Experiment Station Record, vol. I, p. 218, and vol. II, p. 227). The season was on the whole a favorable one for wheat.

Test of varieties (pp. 4–10).—Tabulated data are given for 31 varieties of wheat, 21 of which yielded over 25 bushels of wheat per acre. The weight of wheat per bushel ranged from 57 to 63 pounds with the different varieties. Egyptian (33.5 bushels) and Canadian Finley (32.25 bushels) gave the largest yields. The station offers to distribute, in small quantities, seed of any of the varieties tested. Several of the varieties have been tested for the past 3 years. The tabulated yields of these varieties show that "the Egyptian wheat has made the highest average yield for 3 years; then come Hunter White and German Emperor."

Different methods of seeding (pp. 10, 11).—A tabular statement is given of the results of a comparison of drilling and broadcasting wheat, in each case at the rate of from 0.5 to 2 bushels of seed per acre; and also of drilling 5.5 pecks of seed per acre at depths of 1, 2, 3, and 4 inches. The latter tests were inconclusive. Where from 0.5 to 1.25 bushels of seed were used per acre the results "were very much in favor of the drilling;" but with 1.5 and 2 bushels of seed the yields were better with broadcasting than with drilling.

Test of fertilizers (pp. 11–14).—A continuation of the experiment with fertilizers for wheat, using the same kinds and amounts as in the 2 previous years. "The results are the same as they have been for the last two seasons—that fertilizers, whether used in combination or singly, have no effect upon the yield of wheat. On the same lands, for corn, potatoes, hemp, and tobacco the results of potash fertilizers show very favorably."

EXPERIMENTS WITH OATS, M. A. SCOVELL, M. S., AND C. L. CURTIS (pp. 14–16).—Tabulated notes on 22 varieties of oats. "But one variety

yielded above 40 bushels, viz, Golden Giant Side. * * * Several other varieties yielded well, the best being Barley [38 bushels], Welch [37.25 bushels], and Early Dakota [35 bushels]." A comparison of the yields of 15 varieties, which have been tested for 3 successive years, shows that "the Barley oats and Early Dakota oats have made the best average, both of which we consider good standard varieties."

Massachusetts Hatch Station, Meteorological Bulletins Nos. 32 and 33, August and September, 1891 (pp. 4 each).

A daily and monthly summary of observations for August and September at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Minnesota Station, Bulletin No. 16, April, 1891 (pp. 12).

THE COMMON SCAB OF SHEEP, O. LUGGER, PH. D. (pp. 75–84, figs. 7).—Popular descriptions of scab mites, especially that causing the common scab of sheep (*Psoroptes communis*, var. *ovis*), directions for treatment, and formulas for a number of sheep dips. Special reference is made to the publication of this Department entitled Animal Parasites of Sheep (see Experiment Station Record, vol. II, p. 79), from which six of the figures illustrating the bulletin are taken.

Minnesota Station, Bulletin No. 17, August, 1891 (pp. 24).

MIGRATORY LOCUSTS IN MINNESOTA IN 1891, O. LUGGER, PH. D. (pp. 87–108, figs. 15).—Accounts of observations and experiments by the author in the Red River Valley, illustrated descriptions of the Rocky Mountain locust (*Coloptenus spretus*), lesser migratory locust (*Melanoplus atlantis*), and pellucid locust (*Camnula pellucida*), and suggestions as to remedies. Statements regarding the ovipositing of the Rocky Mountain locust and the legislation needed in Minnesota against locusts are quoted from Bulletin No. 8 of the station (see Experiment Station Record, vol. I, p. 230). The observations of 1891 agreed with those made in previous years in showing that the plowing of land after the eggs have been deposited is an effective means of repression. Hopperdozers were used with good results. The following species of insects were observed to prey upon the locusts: Red mite (*Trombidium locustarum*), blister beetle (*Epicauta pennsylvanica*), ground beetle (*Calosoma calidum*), *Pasimachus* sp., and wolf spider (*Phydippus tripunctatus*). Previous reports on invasions of locusts in Minnesota may be found in Bulletin No. 8 (see Experiment Station Record, vol. I, p. 230) and the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 92).

Minnesota Station, Bulletin No. 18, September, 1891 (pp. 24).

NOTES ON STRAWBERRIES AND RASPBERRIES, 1891, S. B. GREEN, B. S. (pp. 111-121).—*Strawberries.*—Tabulated and descriptive notes on 30 varieties. The leading varieties in yield and quality were Warfield No. 2, Michel Early, Haverland, Bubach No. 5, Park Beauty, Crawford, Shuster Gem, Jessie, Wilson, and Crescent.

The Warfield No. 2 strawberry fertilized with Michel Early gave the largest yield of any variety grown. It yielded something over 90 boxes of berries from one row 160 feet long. This is at the rate of about 7,000 boxes per acre.

[The strawberries tested] were cultivated on the matted-row system and were heavily mulched with straw as soon as the ground was frozen. This mulch was left on to retard the plants until the new growth commenced to look a little yellow. It was then drawn away into the rows from directly over the plants to allow them to push through. This method we have found very satisfactory.

Raspberries.—Descriptive notes on 11 red and 5 cap varieties. "Among the reds I would recommend Marlborough, Hansell, and Cuthbert, and among the black caps, Ohio and Nemaha. Other varieties that should be in every garden, on account of their productiveness and sure bearing qualities, are Schaeffer Colossal and Caroline."

EVERGREENS FROM SEED, S. B. GREEN, B. S. (pp. 121-126).—Brief accounts are given of experiments in raising white pine (*Pinus strobus*), Scotch pine (*P. sylvestris*), white spruce (*Picea alba*), and European larch (*Larix europæa*). The seed was sown in the latter part of April.

The Scotch pine seed started very strongly in 2 weeks. The white pine seed did not start until 2 weeks after the Scotch, but the plants then grew with so much vigor that these seedlings were in a short time as large as those of the Scotch pine. Only a few of the white spruce seeds germinated, and they made a very slow growth. The larch seed was damaged and only a small per cent of it grew.

The following suggestions are made from these experiments:

(1) By following a few simple directions it is a very easy matter to grow evergreens from seeds.

(2) Evergreen seeds germinate readily and the greatest danger comes when the plants are young and growing fast. They are then likely to die if the weather is warm and moist.

(3) The damping-off of evergreens in the seed bed may be greatly reduced, if not entirely prevented, by covering the seed bed with sand or other mulch.

(4) Moist land is not safe to use for a seed bed, and the best seed bed is a rather dry, sandy leaf mold.

(5) Young evergreen seedlings need protection from the sun in very bright or long-continued sunny weather, both in summer and winter. This should be so arranged that the beds may be shaded at pleasure. After ordinary rains the shades should be taken off and need not be put on again until the bed is well dried off.

(6) There is much more danger to coniferous seedlings from warm moist weather than from long-continued drouth, but we can guard against danger from either by exercising a little care.

(7) So very many seedlings may be grown in a small bed that I think it will pay nurserymen and foresters to raise their own seedlings, although they grow very slowly the first few years.

(8) Probably 1 inch is about the right depth at which to sow the seed of hardy evergreens having large seeds, such as the pines and the Norway spruce.

NOTES ON NATIVE FRUITS, S. B. GREEN, B. S. (pp. 126–130, fig. 1).—Brief descriptive notes on the sand cherry (*Prunus pumila*) and the buffalo berry (*Shepherdia argentea*), with accounts of experiments at the station. The author believes these species capable of great improvement.

SUMMER PROPAGATION OF HARDY PLANTS, S. B. GREEN, B. S. (pp. 130–132).—A brief account of an experiment in propagating hydrangea, spiræa, barberry, Tartarian honeysuckle, and 11 varieties of roses. To keep the young plants from wilting in the comparatively dry climate of Minnesota, pieces of burlap were stretched over the beds.

This was not laid horizontally, but was inclined to the south, so that the northern edge was at least 1 foot above the bench, while the southern edge rested directly on the bench. By putting this shade on about 9 o'clock and leaving it on until about 5 we could keep the cuttings from wilting in the driest weather. It was also found that if the burlap was syringed with water it had much greater cooling effect, and that comparatively little attention was necessary in watering.

New Mexico Station, Bulletin No. 3, June, 1891 (pp. 19).

A PRELIMINARY ACCOUNT OF SOME INSECTS INJURIOUS TO FRUITS, C. H. T. TOWNSEND (figs. 8).—Compiled notes on the following insects observed in New Mexico in 1891, with brief accounts of observations by the author and suggestions as to remedies: Vine leaf hopper (*Typhlocyba vitis*), codling moth (*Carpocapsa pomonella*), woolly louse of the apple (*Schizoneura lanigera*), oyster-shell bark louse (*Mytilaspis pomorum*), scurfy bark louse (*Chionaspis furfurus*), apple tree tent caterpillar (*Clisiocampa americana*), peach tree borer (*Sannina exitiosa*), peach aphis (*Myzus persicæ*), green June beetle (*Allorhina nitida*), plum aphis (*Aphis prunifolii*), twelve-spotted diabrotica (*Diabrotica 12-punctata*).

New York Cornell Station, Bulletin No. 29, July, 1891 (pp. 20).

CREAM RAISING BY DILUTION, H. H. WING, B. AGR. (pp. 65–71).—This is a report of a second series of experiments concerning the effects of diluting milk on the completeness of the creaming by setting. The first series, published in Bulletin No. 20 of the station (see Experiment Station Record, vol. II, p. 284), indicated that "instead of aiding the creaming, the addition of water, either warm or cold, was a positive detriment to the thorough separation of the cream."

In the experiments here reported trials were made with the mixed milk of the herd, and with the mixed milk of the five cows furthest advanced in the milking period, the milk being in both cases diluted with one half its volume of water at from 98° to 134° F., and set in cans in a Cooley creamer at about 40° F. Comparisons were made in each case with undiluted milk set under conditions otherwise the same. In all the trials the percentage of fat remaining in the skim milk was larger where the milk had been diluted. The milk of the five cows

somewhat advanced in the milking period creamed very imperfectly, only a little more than one half of the fat of the milk rising in the cream. When the milk of these five cows was heated to 135° F. before setting, part being subsequently diluted one half with water at 135° F. and part set undiluted, the creaming was more satisfactory in both cases, but the skim milk still retained 1.32 to 1.82 per cent of fat, and there was no advantage from diluting. The milk of three of these cows was then mixed with an equal amount of the milk from the herd and it was found that this mixture creamed nearly as completely as the herd milk set alone, the skim milk averaging only 0.49 per cent of fat. "In other words, while dilution with water did not in the least aid in the creaming of this obstinate milk, dilution with the milk of other cows made it cream almost as readily as did the milk of the other cows."

Reference is made to experiments on this subject at the Vermont Station (Newspaper Bulletin No. 3), which "showed a marked advantage from diluting the milk with warm water" when the milk was set at 58° F.; and at the Illinois Station, as reported in Bulletin No. 12 of the station (see Experiment Station Record, vol. II, p. 404), in which there seemed to be an advantage from diluting Holstein milk but a disadvantage from diluting Jersey milk, although "in every case the addition of water caused the cream to rise more quickly than when water was not added."

The author summarizes the work done on this subject at the New York Cornell Station and concludes that "in all of the trials we have made in diluting milk we have never received any advantage whatever from the water added; in fact in all the cases but one the addition of water, either hot or cold, has been a distinct disadvantage."

EFFECTS OF A DELAY IN SETTING UPON THE EFFICIENCY OF CREAMING, H. H. WING, B. AGR. (pp. 71–76).—To study the effects of delay in setting milk on the thoroughness of the creaming and churning, fourteen trials were made in which the creaming of milk set immediately after milking was compared with that of milk which was not set for from 45 minutes to 3½ hours after milking and which in the mean time was either kept warm (82°–95° F.) or allowed to cool; and seven churning tests were made of cream from milk which had received the different treatments. The milk was in all cases stirred up just before setting and was set in Cooley cans in ice water. The data obtained in each of these trials are given in four tables, and similar experiments at the Maine Station reported in the Annual Report of the Station for 1890, part II (see Experiment Station Record, vol. III, p. 22) are cited. "It would seem that the conclusion from all these experiments must be that there is very slight danger of loss of fat in delaying the setting of milk for a considerable time after it is drawn, particularly if the temperature of the milk does not fall much below 80° F."

COMPARISON OF THE BABCOCK CENTRIFUGAL METHOD WITH THE GRAVIMETRIC METHOD OF MILK ANALYSIS, H. SNYDER, B. S. (pp. 77–80).—Data are given on the comparison of the percentages of fat indicated by the Babcock centrifugal method and the gravimetric (asbestus) method in 37 samples of whole milk, 48 of skim milk, 6 of buttermilk, and 5 of butter, duplicate tests being made in many instances.

Of 55 determinations of the fat in whole milk by the Babcock method, the results of 23 differed from those of the gravimetric method by 0.1 per cent or over, while only 7 differed by 0.15 per cent or over, the largest difference being 0.26 per cent. Sixteen of the 77 determinations by the Babcock method in skim milk differed from the gravimetric results by 0.1 per cent or over, the largest difference recorded being 0.2 per cent. Three of the 10 determinations in buttermilk differed by from 0.1 to 0.18 per cent from the gravimetric, and 4 out of the 5 determinations in butter differed from the gravimetric by from 0.28 to 0.7 per cent.

RELATION OF FIBRIN TO THE EFFECTUAL CREAMING OF MILK, H. SNYDER, B. S. (pp. 81, 82).—The results are given of numerous determinations of the fibrin in the milk of several cows, made to ascertain whether a relation exists between the facility of the creaming and the content of fibrin. Measuring the fibrin present by the volume of oxygen liberated when milk was shaken with hydrogen peroxide "it appears that there is no definite relation between the amount of fat in the skim milk [thoroughness of the creaming] and the volume of oxygen liberated. The fat in the skim milk is the measure of the efficiency of the creaming process, and the volume of oxygen liberated is supposed to be proportional to the amount of fibrin present; but the highest percentage of fat in the skim milk is accompanied by as low a volume of oxygen as is the lowest per cent. It is evident that there are other factors of equal if not of more importance than fibrin that affected the creaming process of these samples."

New York Cornell Station, Bulletin No. 30, August, 1891 (pp. 40).

SOME PRELIMINARY STUDIES OF THE INFLUENCE OF THE ELECTRIC ARC LIGHT UPON GREENHOUSE PLANTS, L. H. BAILEY, M. S. (pp. 85–122, plates 2, figs. 7).—A record of experiments by the author in the winter and spring of 1890 and 1891 in a low, flat-roofed forcing house (20 by 60 feet), designed for the growing of lettuce, radishes, and cuttings.

The house is ventilated entirely from the peak by small windows hinged at the ridge. It is heated by steam, the riser running overhead and the returns all lying under the benches. This house was divided by a tight board partition into two nearly equal portions for our purpose. One compartment was treated to ordinary conditions—sunlight by day and darkness by night—and the other had sunlight during the day and electric light during a part or whole of the night. In all

the experiments the lamp was suspended from the peak of the house, the arc being 2½ feet above the soil of the bench over which it was placed. *

During the first winter (January to April, 1890) we used a 10 ampere, 45 volt. Brush arc lamp of 2,000 nominal candle power. This was run all night—from dusk until daylight—from January 23 to April 12. At first the light was started at 4:30 in the afternoon and ran until 7:30 in the morning, but as the season advanced the run was shortened, until in April it ran from 7 o'clock till 5. For the first 6 weeks the light was naked, but during the remainder of the time an ordinary white opal globe was used.

The experiments were in three series, (1) with a naked light running all night, (2) with a light protected with a white opal globe and running all night, (3) with a naked light running a part of the night.

Experiments with a naked light running all night.—These were with radishes, carrots, endive, spinach, cress, lettuce, and peas.

"The general effect of the light was to greatly hasten maturity, and the nearer the plants grew to the light the greater was the acceleration. This tendency was particularly marked in the leaf plants—endive, spinach, cress, and lettuce. The plants 'ran to seed' before edible leaves were formed, and near the light the leaves were small and curled."

Details are given in notes and tables, and the results are illustrated with cuts of specimen plants from both the light and dark houses. In the case of lettuce it was observed that the plants did not increase in size uniformly with the increase in distance from the lamp. The lower and higher plants alternated somewhat regularly, although there was a general progression in height. "This alternating elevation and depression is perhaps due to the concentric bands of varying intensity of light which fall from the arc and which are caused by the uneven burning of the carbons."

In the case of endive "it chanced that for a time two rows grew parallel to each other in the light house, but one stood in full light while the other was shaded by an iron post 1.5 inches in diameter." At the end of 2 months the plants in the row exposed to the full light averaged 49.6 grains in weight, while those in the shaded row averaged 93.8 grains.

In the dark house an average plant of the same age weighed 575 grains, and it was larger leaved and darker colored than those grown in the other compartment. * * *

The young radish plants [on the highest bench] were strongly attracted by the light, and in the morning they all leaned at an angle of from 60° to 45° towards the lamp. During the day they would straighten up, only to reach for the lamp again on the succeeding night. This was repeated until the roots began to swell and the plant became stiff. As the plants grew, the foliage became much curled, and the amount of this injury was in direct proportion to the nearness to the lamp. Those nearest the lamp (within 3 to 6 feet) were nearly dead at the expiration of 6 weeks, while those 14 feet away showed little injury to the leaves.

The following figures represent the average weight in ounces of radishes in the light and dark houses respectively: Entire plant, 0.18 and

0.31; top, 0.08 and 0.14; tubers, 0.07 and 0.16. The percentages of marketable tubers were 27 and 78.

The table shows that the crops obtained in the dark or normal house were about twice as large as those in the light compartment. The entire plants and the tops were almost half lighter in the light house, and the tubers were more than half lighter, while the per cent of tubers large enough for market was as 9 in the light house to 26 in the dark house. And it should also be said that the average size of the tubers graded as marketable was less in the light house than in the other. * * *

A chemical analysis of samples of radishes from the light house (in both full light and shadow) and the dark house gave the following results:

Samples.	Ash.	Potash, K_2O.	Chlorophyll.	Total nitrogen.	Albuminoid nitrogen.	Amide nitrogen.	Albuminoids (albuminoid N. x 6.25).
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Light house, full light	3.84	0.38	6.22	1.36	1.24	0.12	7.75
Light house, in shadow	3.76	0.34	6.12	1.38	1.20	0.12	7.50
Dark house	3.26	0.15	5.02	1.34	1.01	0.33	6.31

These figures show that the plants under the electric light had reached a greater degree of maturity than those in the normal or dark house. * * *

[Dwarf peas were grown on two benches, one of which shaded about half of the other.] In the shaded portion the peas were larger and more productive than those in full light, although the latter were farther from the lamp. The average heights of plants were as follows: Light house, in full light, 4.8 inches; light house, in shade, 5.3 inches; dark house, 5.8 inches. The plants in the light house, particularly those in direct light, blossomed about a week in advance of those in the dark house, and they gave earlier fruits. but the productiveness was less, being in the ratio of 4 in the light house to 7 in the dark house. The decrease in production was due largely to the fewer number of peas in each pod, for the number of fruitful pods produced in each case was as 7 in the light house to 9 in the dark house, and there were many seedless pods in the light house. In other words, the production of pods (or flowers) was about the same in both houses, but the plants in the light house produced only four sevenths as many seeds as those in the dark compartment.

The question whether the injury was due to the electric light itself or to continuous light during the whole twenty-four hours, was tested with various plants. At first seedling radishes were covered with pots during the day and exposed to the electric light for about 12 hours at night. These made a slender and sickly growth, assuming a faint green color, and died in 3 or 4 weeks.

"The experiment was now conducted upon a larger scale, and at a time when the hours of sunlight were about equal to the hours of electric light. A tight wooden frame was placed upon the soil of a bench at one end of the light house. This frame was provided with a tight cover which was kept on during the day and removed at night." Radish seeds planted in this manner, both in soil and in pots, germinated and made a very rapid, spindling, and nearly colorless growth for a short time, but in 3 or 4 weeks the young plants were all dead. Similar results were obtained with lettuce, beans, corn, and potatoes,

Another series of tests was made by covering well-established plants in the beds. A tight box, 18 inches square and 1 foot high, was placed over certain plants during the daytime, and was removed at night and placed over contiguous plants of the same kind. Thus one set of plants received only electric light and one only sunlight, and inasmuch as both were covered during half of the twenty-four hours, any error which might have arisen from the covering itself (as lack of ventilation and increased heat) was eliminated. February 7 certain radishes in the light house which had been planted 2 weeks were covered. In 8 days some of the plants which were covered during the day were dead and the remaining ones were very weak. At the same time those which were covered during the night had made a better growth than they had before, and better than contiguous plants which had not been covered. An examination of the leaves of the plants receiving only the electric light showed that they contained no starch and very little or no chlorophyll. February 8 two lots of beans and radishes were planted in pots sunk to their brims in the soil between the radish rows in the light house. One lot was covered during the day and the other during the night, as above. Germination was the same in both lots. February 25 the daylight beans had made a stocky growth of 3½ to 4 inches, while the electric-light lot had made a weak growth of 8 to 9 inches. Radishes behaved in a similar manner. March 3 the leaves of the electric light beans began to wither, and both beans and radishes were dead March 10. The daylight lots continued to grow thriftily.

Similar experiments with plants of German ivy (*Senecio scandens*), carnation, begonia, and peas also showed the injurious effects of the electric light.

The above experiments show conclusively that within the range of an ordinary forcing house the naked arc light running continuously through the night is injurious to some plants; and in no case did we find it to be profitable. But the fact that the light hastens maturity or seed bearing suggests that a modified light may be useful under certain conditions.

Experiments with a protected light running all night.

Early in March, 1890, an ordinary white opal globe was placed upon the lamp, and for 5 weeks experiments similar to those already described were conducted. The effect of the modified light was much less marked than that of the naked light. Spinach showed the same tendency to run to seed, but to a much less extent, and the plants were not affected by proximity to the lamp. Lettuce, however, was decidedly better in the electric light house. Radishes were thrifty in the light house and the leaves did not curl, but they produced less than in the dark house, although the differences were much less marked than in the former experiments. These second series of experiments can scarcely be compared with the former ones, because of the greater amount of sunlight which the plants received in the lengthening days of spring. The figures obtained from radishes, however, may afford a practically accurate comparison because of their rapid growth.

The following figures represent the average weight in ounces of radishes in the light and dark houses, respectively: Entire plant, 0.29 and 0.33; top, 0.12 and 0.11; tubers, 0.17 and 0.22. The percentages of marketable tubers were 89 and 94.

The loss due to the electric light averages from 1 to 5 per cent in the different comparisons, while the loss occasioned by the naked light was from 45 to 65 per cent. It is also noticeable that while the tops or leaves were lighter under the naked light, they were heavier under the modified light than those of normal plants; and this is interesting in connection with the fact that lettuce did better under the modified light than in the dark house. * * *

The carrots (Shorthorn Scarlet) gave indifferent results. They did not appear to be affected greatly even by the naked light when growing directly opposite to it and but 3 or 4 feet away. Carrots require such a long period of growth that the first good picking was not obtained until the end of the experiment in April. The plants therefore grew under both the naked and protected lamps. * * The figures [given in the article] show that the plants which grew directly in front of the lamp were but little inferior to those which stood 10 or 12 feet away, or even to those in the dark house. No other plant in our experiments has withstood the electric light so well.

Experiments with the naked light running a part of the night.—"From January 16 to May 1, 1891, the experiment was conducted under new conditions. The arrangement of the house or compartment remained as before, but the lamp was connected with a street-lighting system and the light ran but a few hours, and never on moonlight nights. In this test we used a 10 ampere 45 volt 2,000 nominal candle power Westinghouse alternating current lamp." The plants experimented with were radishes, peas, lettuce, and a variety of ornamental plants, mostly tulips, verbenas, petunias, primulas, heliotropes, and coleus.

These ornamentals were mostly named one-colored varieties, and they were grown to enable us to make observations concerning the influence of electric light upon color. In this experiment the lighting of the compartments was reversed during the last month in order to eliminate any error which might arise from any minor differences in the temperature or other conditions of the two portions of the house. [A detailed tabular record is given of the dates and hours of lighting.]

Of radishes, the White Box and Cardinal Globe were grown. The foliage was noticeably larger in the electric light house, as it had been under the modified light, but the tubers were practically the same in both houses, and the date of maturity was the same. Notwithstanding its greater size, the foliage in the light house showed some signs of curling.

American Wonder and Advance peas were grown, and in every case they were larger and more fruitful in the dark house. The electric light did not increase the size of leaves, as it did in the radishes. The results are similar to those obtained in 1890.

The lettuce, however, was greatly benefited by the electric light. We had found that under the protected light the lettuce had made a better growth than in normal conditions, but now it showed still greater difference. Lettuce of two varieties—Landreth Forcing and Tennis Ball or Boston Market—was grown. * * * Three weeks after transplanting (February 5) both varieties in the light house were fully 50 per cent in advance of those in the dark house in size, and the color and other characters of the plants were fully as good. The plants had received at this time 70½ hours of electric light. Just a month later the first heads were sold from the light house, but it was 6 weeks later when the first heads were sold from the dark house. In other words, the electric-light plants were 2 weeks ahead of the others. This gain had been purchased by 161¾ hours of electric light, worth at current prices of street lighting about $7.

This lettuce test was repeated and was watched very closely when the lamp was transferred to the compartment which had formerly been kept under normal conditions. The same results were obtained, and the differences in the two crops were so marked as to arrest the attention of every visitor. The electric light plants were in every way as good in quality as those grown in the dark house; in fact the two could not be told apart except for their different sizes.

[In another experiment where Landreth Forcing lettuce was grown] the electric-light plants were upon the benches 44 days before the first heads were sold. During

this time there were 20 nights in which the light did not run, and there had been but 84 hours of electric light, worth about $3.50. In order to compute the cost of growing lettuce by the aid of the electric light, it is necessary to know how far the influence of the light will extend. This we do not know, but the lamp exerted this influence throughout a house 20 by 30 feet, and the results were as well marked in the most remote part as they were near the lamp.

The results obtained from lettuce suggest many questions, all of which must be answered by experiment. We need to know if there is any particular time in the life of the lettuce plant when the light has a predominating influence; if a mild light is as good as a strong one; if the failure of the light during the moonlight nights is a serious drawback; to what distance the influence of the light extends; if the same results can be obtained by hanging the lamp over the house instead of inside it, and by that means lighting several houses at once; if other plants can be profitably forced by means of electric light. In all these directions, and many others, we are planning experiments for the coming years.

The influence of the light upon productiveness and color of flowers was found to vary with different species and different colors within the same species. Several named varieties of tulips gave interesting results. * * When these came into full flower, it was found that in every case the colors were deeper and richer in the light house; but the colors lost their intensity after 4 or 5 days and were indistinguishable from those in the dark house. The plants in the light compartment had longer stems and larger leaves than the others; and there was a greater number of floriferous plants in the light. The tulips were grown at a distance of 10 and 12 feet from the lamp.

Verbena flowers near the light were uniformly injured. * * * Scarlet, dark red, blue, and pink flowers within 3 feet of the light soon turned to a grayish white, and this discoloration was noticeable to a distance of 6 and 7 feet. The plants bloomed somewhat earlier in the light house than in the other.

A few fuchsias were grown in both houses. Those in the light house were about 8 feet from the lamp, and they flowered 3 days earlier than the others. The colors were not changed.

Heliotropes of various-named varieties standing 9 and 10 feet from the lamp did not appear to be affected in any way.

White ageratums stood at 3 feet from the lamp. The flowers soon turned brown and sere. Those in the dark house remained white three times as long.

Chinese primulas at 7 feet from the light were not affected, but those 4 feet away, especially the lilacs, were changed in color. The lilac was bleached out to pure white wherever the light struck squarely upon the flowers, but any portion of the flower which chanced to be shaded by a leaf or another petal retained its color for a time and then gradually became duller. * *

Petunias were much affected by the light. The plants were much taller and slenderer in the light, even at the farthest corners of the house, and they bloomed earlier and more profusely. * * * White petunias were not changed in color by the light, but purple ones quickly became blue, especially near the lamp. * * *

Coleus plants of various colors were placed at different distances from the lamp March 31. After 2 nights the plants within 3 feet of the lamp were much affected. Reds became yellow, browns turned green, greens lost their brightness, and dark purple became glossy black. [Plants farther away from the light changed color more slowly.]

[Observations upon the duration of flowers of various colors and species in both houses are tabulated.] Perhaps the most noticeable feature of these figures is the lack of uniformity in duration under similar conditions. Neither the distance from the lamp nor the hours of light received by the flower appears to determine the duration. The longevity of the flower is probably determined more by the vigor and general condition of the plant than by the variations in the amount of light, although this subject is one which demands closer investigation.

[Numerous auxanometer readings were made upon representative plants during 1890–91. A record of the growth of two petunia plants, alike in all respects, is given.]

The average growth per hour is as follows:

With electric light, 8 to 11 p. m., 0.0416 inches; 11 p. m. to 8 a. m., 0.0243 inches; 8 a. m. to 8 p. m., 0.0312 inches. Without electric light, 8 to 11 p. m., 0.0234 inches; 11 p. m. to 8 a. m., 0.0225 inches; 8 a. m. to 8 p. m., 0.0234 inches.

The greatest growth took place when the electric light was burning.

In all these experiments with ornamental plants it was noticeable that the light exercised a very injurious effect within a radius of about 6 feet. Between 6 and 8 feet the results were indifferent, and beyond that point there was usually a noticeable tendency towards a taller and straighter growth, and it seemed to us that at distances of a dozen feet or more the flowers were more intense in color, particularly when they first opened, There was usually a perceptible gain in earliness in the light house also. On the whole, I feel that it will be possible some day to use the electric light in floricultural establishments to some pecuniary advantage.

Experiments elsewhere.

The first experiment to determine the influence of electric light upon vegetation was made by Hervé-Mangon in 1861.* This experiment showed that the electric light can cause the production of chlorophyll or the green color in plants, and also that the light can produce heliotropism, or the phenomenon of turning or bending towards the light.

In 1869 Prillieux † showed that the electric light, in common with other artificial lights, is capable of promoting assimilation, or the decomposition of carbon dioxide and water.

[The only other important investigations of the subject from a horticultural standpoint appear to have been those of C. W. Siemens in England, and P. P. Dehérain in France.] Dr. Siemens's experiments ‡ may be divided into two series; in one series the lamp was placed inside the greenhouse and in the other suspended over it.

[In his first experiment a lamp of 1,400 candle power was used. The foliage of melon and cucumber plants placed within 3 or 4 feet of this lamp was much injured. When the plants were removed to a distance of 7 or 8 feet they showed signs of recovery and made new leaves.] In general all plants which were exposed to normal conditions during the day and to 6 hours of electric light at night "far surpassed the others in darkness of green and vigorous appearance generally." The flavor was fully as good in the electric-light fruits as in the others. These results were supplemented by a larger experiment in the winter of 1880–81. In this case a lamp of 4,000 candle power was used, and it was placed inside a house of 2,318 cubic feet capacity. The light was run all night and the arc was at first not protected by a globe. The "results were anything but satisfactory," the plants soon becoming withered. At this point a globe of clear glass was placed upon the lamp, and thereafter the most satisfactory results were obtained. Peas, raspberries, strawberries, grapes, melons, and bananas fruited early and abundantly under continuous light—solar light by day and electric light by night. The strawberries are said to have been "of excellent flavor and color," and the grapes of "stronger flavor than usual." The bananas were "pronounced by competent judges unsurpassed in flavor," and the melons were "remarkable for size and aromatic flavor." Wheat, barley, and oats grew so rapidly that they fell to the ground from their own weight. The beneficial influence of the clear glass globe was therefore most marked. * * *

In the other series of experiments Siemens placed an electric lamp of 1,400 candle power about 7 feet above a sunken melon pit which was covered with glass. The

*Compt. rend., 53, 243.

†Compt. rend., 69, 410.

‡Proc. Roy. Soc., 30, 210, 293. Rep. British A. A. S., 1881, 474. See also abstract in Nature, 21, 456 (Mar. 11, 1880), and an editorial in the same issue.

light was modified by a clear glass globe. In the pit seeds and plants of mustard, carrots, turnips, beans, cucumbers, and melons were placed. The light ran 6 hours each night and the plants had sunlight during the day. In all cases those plants "exposed to both sources of light showed a decided superiority in vigor over all the others, and the green of the leaf was of a dark, rich hue." Heliotropism was observed in the young mustard plants. Electric light appeared to be about half as effective as daylight. A great difficulty experienced in this experiment was the film of moisture which condenses on greenhouse roofs at night and obstructs the passage of light. The light was at one time suspended over two parallel pits nearly 4 feet apart, and the effect was observed upon plants under the glass and in the uncovered space. In all cases the growth of the plants was hastened. Flowering was hastened in melons and other plants under the glass. Strawberries which were just setting fruit were put in one of the pits and part of them were kept dark at night while others were exposed to the light. After 14 days, the light having burned 12 nights, most of the fruits on the lighted plants "had attained to ripeness, and presented a rich coloring, while the fruit on those plants that had been exposed to daylight only had by this time scarcely begun to show even a sign of redness." He concludes that a lamp of 1,400 candle power produced a maximum beneficial result on vegetation at a distance 3 meters (nearly 10 feet) above the glass, but "the effect is nevertheless very marked upon plants at a greater distance."

At the close of his experiments Siemens was very sanguine that the electric light can be profitably employed in horticulture, and he used the term "electro-horticulture" to designate this new application of electric energy. * * *

Dehérain's experiments* were conducted at the Exposition d'Electricité, Paris in 1881. A small conservatory standing inside the Exposition building was divided into two compartments. One compartment was darkened and the glass painted white upon the inside; this received the electric light and all solar light was excluded. The other compartment was not changed. * * *

A lamp of 2,000 nominal candle power was used. At first the naked electric light was used and it ran continuously.

[A number of different kinds of plants were experimented with.] At the expiration of 2 weeks the condition of the plants was so bad that a change was made, and thereafter a transparent glass globe was used upon the lamp.

[From his experiments Dehérain drew the following conclusions:]

(1) The electric light from lamps contains rays harmful to vegetation.

(2) The greater part of the injurious rays are modified by a transparent glass.

(3) The electric light contains enough rays to maintain full-grown plants 2½ months.

(4) The light is too weak to enable sprouting seeds to prosper or to bring adult plants to maturity.

Finally, observations† were made more recently upon the influence of the electric light upon plants in the Winter Palace at St. Petersburg. It was observed that in a single night ornamental plants turned yellow and then lost their leaves. Yet it is well known that incandescent lamps can be lodged in the corolla of a flower without injuring it.

Recapitulation.—The author does not consider that the results thus far obtained will warrant many definite conclusions.

Yet there are a few points which are clear: The electric light promotes assimilation, it often hastens growth and maturity, it is capable of producing natural flavors and colors in fruit, it often intensifies colors of flowers, and sometimes increases the production of flowers. The experiments show that periods of darkness are not necessary to the growth and development of plants. There is every reason, therefore, to suppose that the electric light can be profitably used in the growing of plants.

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*Ann. Agron., 7, 551 (1881). † Ann. Agron., 14, 281 (1888).

It is only necessary to overcome the difficulties, the chief of which are the injurious influences upon plants near the light, the too rapid hastening of maturity in some species, and in short the whole series of practical adjustments of conditions to individual circumstances. Thus far, to be sure, we have learned more of the injurious effects than of the beneficial ones, but this only means that we are acquiring definite facts concerning the whole influence of electric light upon vegetation; and in some cases, notably in our lettuce tests, the light has already been found to be a useful adjunct to forcing establishments.

The experiments bring out more clearly the fact that the growth of plants may be continuous, and show that the injury to plants from the electric light can not result from any gases arising from the lamp itself.

It is highly probable that there are certain times in the life of the plant when the electric light will prove to be particularly helpful. Many experiments show that injury follows its use at that critical time when the plantlet is losing its support from the seed and is beginning to shift for itself, and other experiments show that good results follow its later use. This latter point appears to be contradicted by Dehérain's results, but his experiments were not conducted under the best normal conditions.

On the whole, I am inclined towards Siemens's view—that there is a future for electro-horticulture.

New York Cornell Station, Bulletin No. 31, September, 1891 (pp. 17).

THE FORCING OF ENGLISH CUCUMBERS, L. H. BAILEY, M. S. (pp. 125–139, figs. 7).—An account of experiments by the author in raising English cucumbers in the greenhouse during the winter of 1890–91 with a view to encouraging their introduction in this country. The bulletin contains descriptions of the greenhouse used: methods of culture and training; and notes on the appearance and history of the English varieties, on pollination and crossing, and on the insect enemies of cucumbers. For details regarding the general requirements of houses, temperature, and moisture for the forcing of cucumbers, the reader is referred to Bulletins Nos. 25 and 28 of the station (see Experiment Station Record, vol. II, p. 507, and vol. III, p. 91), in which experiments with beans and tomatoes are reported. Some attempts were made to obtain a variety of English cucumbers suitable for out-door use by crossing the Sion House and Medium Green varieties.

Fruits of unusual promise have been obtained, but they have not produced good seeds. Some of the mongrel fruits developed a peculiar weakness in the tendency of the placentæ or cell walls to decay. The seeds did not mature and the soft, pulpy tissue about them solidified. Near the apex of the fruit the placentæ tended to break away from the body, and in the cavities decay set in and extended finally to the base of the fruit. All the fruits upon one of the mongrel plants behaved in this manner. In no case had the fruit been injured nor was the decay visible upon the exterior until it had extended well down the fruit. I am unable to account for it.

In most instances the mongrel vines resembled the Medium Green (the staminate parent) more than the Sion House. The fruits were generally intermediate, although almost every gradation was observed. Sometimes the fruits would vary widely upon the same plant. A number of vines bore beautiful fruits, twice as long as the Medium Green, nearly cylindrical, with very few spines, and we are looking for good results from this cross.

The following summary is taken from the bulletin:

(1) The English forcing cucumber demands a rather high temperature [60° to 65° F. at night, and 70° to 75° by day], brisk bottom heat, abundance of water, and a very rich soil.

(2) Great care should be exercised to maintain a vigorous growth from the start, and particularly to avoid injury from insects and mildew.

(3) In this latitude English cucumbers produce marketable fruits from the seed in from 80 to 100 days.

(4) The plants must be trained. Two or three strong arms may be allowed to each root, and these should be stopped as soon as they reach the space allotted to adjoining plants. Part of the young growth should be removed, and in midwinter, especially in dark houses, some of the leaves may be removed to advantage.

(5) The fruits should not be allowed to lie upon the soil, and the heavy ones are sometimes supported in a sling to prevent injury to the vines.

(6) Sion House, Telegraph, Kenyon, and Lorne are good varieties. The fruits, especially of the longer sorts, are usually marketed before they attain their full size.

(7) The English forcing cucumber has been produced by selection from shorter and spiny field sorts within recent times.

(8) Hand pollination appears to be essential upon the first flowers; but cucumbers set and mature with no pollen whatever, though in that case fruits are usually later and probably fewer. Pollination must be employed when seeds are desired.

(9) Seed bearing is not necessarily associated with deformity of fruits, although upon some plants it appears to conduce to the production of swollen ends, which, however, appear to be avoided by swinging the fruits.

(10) The spotted mite and aphis (*Aphis rumicis?*) can be destroyed by Hughes's Fir Tree Oil, and the powdery mildew (*Oidium erysiphoides*, var. *cucurbitarum*) is kept in check by fumes of sulphur and by the ammoniacal carbonate of copper.

North Carolina Station, Bulletin No. 78*a* (Meteorological Bulletins Nos. 19 and 20), July, 1891 (pp. 34).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, and tabulated summaries of meteorological observations of the North Carolina weather service, coöperating with the United States Weather Bureau, for April and May, 1891.

Ohio Station, Bulletin Vol. IV, No. 3 (Second Series), August 1, 1891 (pp. 20).

COMMERCIAL AND OTHER FERTILIZERS ON WHEAT, C. E. THORNE AND J. F. HICKMAN, M. S. A. (pp. 57–71).—This bulletin contains an account of the second and third years' experiments with wheat on the same plats, the object being to test the profitableness of using fertilizers for wheat on Ohio soils, and the special needs of the soil for this crop. The land used contained 22 tenth-acre plats, separated from each other by intervening strips 2 feet wide, and had been in clover in 1887. The fertilizers applied per acre each year were as follows: Dissolved boneblack 320 pounds, muriate of potash 160 pounds, and nitrate of soda 160 pounds, were used alone and combined two by two,

and all three together; the bone black and muriate of potash combined in the same amounts were used with 320 pounds and 480 pounds of nitrate of soda and 120 pounds of sulphate of ammonia, respectively; muriate of potash and nitrate of soda, 160 pounds each, were used with 300 pounds of dissolved South Carolina rock and 400 pounds of ground Thomas slag, respectively; and barnyard manure 8 tons and linseed meal 1,800 pounds were each used on one plat. Each plat received the same fertilizers as in the preceding year; and as before, 8 plats remained unmanured.

Penquite Velvet Chaff wheat was sown on all the plats the last of September in each year, the fertilizers being applied broadcast just before seeding, except the nitrate of soda, which was applied the following April.

An experiment on a similar plan was made in Columbiana County in 1890.

The results of all three experiments are tabulated and discussed, and reference is made to the Rothamsted experiments with fertilizers for wheat. The results are also reported of a trial at the station in which wheat was grown in a rotation, being preceded by corn and oats. The authors' conclusions from the several experiments follow:

In 1890 the various fertilizers used produced in every case some increase of crop. When nitrate of soda was used alone its cost was recovered in the increase of crop, counting wheat at $1 per bushel, but in no other case in the station test was the cost of any of the fertilizers or combinations of fertilizers recovered, except in that of barnyard manure.

In the test in Columbiana County the increase of crop on plat 2 apparently justified the use of superphosphate, but this increase was not confirmed by the duplicate plats 5 and 8; hence we are led to doubt whether this increase may not have been due to the natural superiority in the soil of this plat. In general the fertilizers added less to the unaided yield of the Columbiana County soil than they did to that of the station soil, notwithstanding the fact that the unfertilized plats on the station farm yielded twice as much wheat on an average as did those on the farm in Columbiana County.

In the tests of 1891 at the station the fertilizers have in every case caused a decrease of crop where superphosphate was used. Nitrate of soda, alone or with potash, has produced a slight increase; but in no case has the increase been sufficient to justify the use of the fertilizer, and this applies both to the wheat grown continuously on the same soil and to that grown in rotation.

In the tests of 1891 the wheat grown in rotation without fertilizers has yielded as large an average crop as the best obtained from the use of the fertilizers in 1890, although the yield from the unfertilized plats under continuous cropping was practically the same in both seasons.

Some fertilizing materials and their uses, C. E. Thorne and J. F. Hickman, M. S. A. (pp. 71–76).—A popular discussion of the commercial sources of nitrogen, phosphoric acid, and potash, and the use of these various materials.

Ohio Station, Bulletin Vol. IV, No. 4 (Second Series), August 25, 1891 (pp. 23).

EXPERIMENTS IN WHEAT SEEDING AND TREATMENT OF SEED FOR SMUT, J. F. HICKMAN, M. S. A. (pp. 77–89).—These included experiments in (1) thick and thin seeding, (2) seeding at different depths and by different methods, and (3) treatment of seed with copper sulphate solutions and hot water for smut. The first two were in continuation of experiments recorded in previous publications of the station. Accounts of these experiments in 1889 and 1890 are given in Bulletin vol. II, p. 115, and vol. III, p. 175, of the station (see Experiment Station Record, vol. I, p. 287, and vol. II, p. 249).

Thick and thin seeding.—In 1891 this experiment was conducted on light clay loam, with a gravel subsoil, which had been cropped with wheat for 9 successive years. Results are tabulated for Velvet Chaff (Penquite) and Deitz varieties. Owing to the ravages of the wheat midge, which were greater in the case of the Velvet Chaff, the results obtained from the two varieties are not comparable. The yields in 1891 ranged from 26 bushels per acre for the 2-peck rate to 28.8 bushels for the 6-peck rate. For the 10 years the 7-peck rate has given the highest average yield (37.9 bushels), but is closely followed by the 5 and 6 peck rates (37.4 and 36.4 bushels). "Seeding above 7 pecks per acre gives fewer bushels but a superior quality of grain."

Methods of culture and different depths of seeding.—The results obtained by different methods of seeding, mulching, and planting at different depths are given in one table for 1891 and in another for seven seasons. The variety of wheat used in 1891 was Martin Amber. In 1891 the yields from planting at depths of from 2 to 4 inches were nearly the same. "Broadcast seeding has given as good results this year as drilling, but in a series of years drilling has produced the largest crop. Very light mulching has apparently been of some benefit this year. Heavier mulching has invariably injured the crop. Cross-drilling has shown no advantage this year. No larger crop has been produced this year from mixed seed of two varieties than from pure seed of the same varieties sown separately."

Treatment of seed to destroy smut germs.—Notes and tabulated data for an experiment in which wheat seed was immersed for 10 minutes in sulphate of copper solutions (12 gallons of water to from 2 to 12 ounces of copper sulphate), and in hot water (124° to 152° F.). Both treatments were effective, but that with hot water (132° to 135° F.) is much more economical.

COMPARATIVE TESTS OF VARIETIES OF WHEAT, J. F. HICKMAN, M. S. A. (pp. 89–97).—These were in continuation of the tests reported in Bulletin vol. III, p. 184, of the station (see Experiment Station Record, vol. II, p. 250). In 1891 the test was on river bottom land, with 52 varieties on clover sod and 11 on wheat stubble. Tabulated data are given for the 63 varieties tested this year and for 16 varieties tested during 7 years.

Wheat, comparative yield of varieties for 7 years.

[Bushels per acre.]

Varieties.	1884.	1886.	1887.	1888.	1889.	1890.	1891.	Average.
Valley	38.1	45.8	34.9	33.6	44.5	36.1	39.5	38.9
Red Fultz	38.2	54.0	35.2	30.9	37.3	32.5	32.4	37.2
Diehl-Mediterranean	39.2	42.7	26.9	34.1	42.0	27.5	37.6	35.7
Royal Australian	40.2	49.6	38.8	18.1	45.6	32.6	24.5	35.6
Nigger	36.6	51.0	24.6	32.0	40.6	31.7	31.6	35.4
Egyptian	30.6	41.7	28.0	32.2	46.1	34.0	37.2	35.4
Poole	32.6	61.2	25.5	17.5	43.6	29.6	35.9	35.1
Penquite Velvet Chaff	33.3	42.9	37.4	26.6	41.3	35.2	27.9	34.9
Silver Chaff Smooth	39.7	45.2	30.0	31.4	37.8	29.5	30.1	34.8
Tasmanian Red	49.6	45.6	22.1	25.0	37.1	29.3	33.1	34.5
Democrat	35.9	40.4	24.5	25.0	45.3	30.4	38.1	34.2
Martin Amber	45.2	36.7	21.4	28.2	47.8	29.1	28.8	33.9
Theiss	29.4	46.2	29.5	36.8	37.8	25.4	30.5	33.7
Fultz	36.7	38.4	....	23.1	30.1	34.2	35.6	33.0
Landreth	31.6	39.9	32.0	25.6	41.1	....	25.3	32.6
Mediterranean	31.0	38.7	22.3	28.2	36.8	29.3	34.5	31.5
Mean	37.2	45.0	28.9	28.0	40.9	31.9	32.7	34.8

"Among the newer varieties Mealy and Rudy are the most promising. * * * The variations in weight per measured bushel in the several varieties between the screened and unscreened grain has run from nothing in some varieties up to 13 per cent in others. The proportion of straw to grain was greater this year on land where wheat had been grown for 10 years than it was on land where a system of rotation had been followed."

Rhode Island Station, Bulletin No. 10, May, 1891 (pp. 7).

MIXED FOOD IN CASES OF FAULTY APPETITE IN HORSES AND NEAT STOCK, F. E. RICE, M. R. C. V. S. (pp. 125–128).—The causes of loss of appetite by farm stock are briefly discussed and formulas for condimental foods are given.

The following formula is useful in the greater number of cases: Ground or crushed oats and corn meal of each 5 pounds, oil meal 0.25 of a pound, common table salt 2 ounces. If the animal seems in need of a tonic or is troubled with intestinal worms, there may be mixed with each ration, as above given, a desertspoonful of powdered gentian and a small teaspoonful of the dried sulphate of iron; these are to be had of any druggist.

SORE SHOULDERS OR COLLAR GALLS IN HORSES, F. E. RICE, M. R. C. V. S. (pp. 128, 129).—The causes and treatment of collar galls in horses are briefly discussed. The author advises the employment of a cast-iron collar, such as is coming into use in some places, to prevent galling the shoulders.

South Carolina Station, Bulletin No. 1 (New Series), July, 1891 (pp. 15).

FERTILIZER ANALYSES.—Tabulated data for analyses of 118 samples of ammoniated fertilizers, 57 of acid phosphate (with or without potash), 30 of cotton-seed meal, and 16 of kainit. Nine of the fertilizers analyzed were found below guaranty in one or more ingredients.

Texas Station, Bulletin No. 15, May, 1891 (pp. 16).

INFLUENCE OF CLIMATE ON COMPOSITION OF CORN PLANTS, H. H. HARRINGTON, M. S. (pp. 77–86).—This experiment was made with a view to determining the variation in the composition of the same varieties of corn when grown in different sections of the country. The plan of the experiment originated with the Texas Station. Seed corn raised in Wisconsin, New York, Maryland, Kansas, Kentucky, Texas, and Georgia, one variety from each State, was sent to the stations in Mississippi, Maryland, Georgia, Connecticut, New York, Wisconsin, and Kansas in the spring of 1890, for planting. Analyses were to be made by the Texas and the Connecticut State Stations of the seed corn used and the crop secured in each of the States. For various reasons reports were only received from Connecticut, New York, and Georgia. The 7 varieties of corn grown in New York and Georgia and 2 grown in Connecticut were analyzed by the Texas and Connecticut State Stations, and the results are reported in the bulletin. Considerable discrepancies are noticeable between these two sets of analyses. Only the analyses by the Texas Station will be considered here.

The corn raised in New York from seed grown in Kentucky, Maryland, and Texas was lower both in protein and fat than the seed from which it came, and that grown from Wisconsin, Kansas, and Georgia seed showed a slight increase in protein but a decline in fat. The corn raised in Georgia from seed grown in New York, Kansas, and Kentucky was lower than the seed corn in both protein and fat, and that from Wisconsin seed was slightly richer than the seed in both these constituents. No wider differences were presented than those between corn raised from the same variety of Northern-grown seed in Connecticut and New York, as will be seen from the following example:

Composition of dry matter of corn grown in different States.

	Seed corn grown in Wisconsin.	Corn from same seed raised in—		
		Connecticut.	New York.	Georgia.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Crude ash	1.39	1.53	1.71	1.02
Crude cellulose	2.41	2.29	2.67	1.83
Crude fat	4.76	5.59	4.62	5.43
Crude protein	11.29	9.07	12.24	11.60
Nitrogen-free extract	80.15	81.52	78.76	80.12
Total	100.00	100.00	100.00	100.00

The corn grown in Georgia from Georgia seed likewise showed considerable variations in composition from the seed. It is obviously impossible to make any general deductions as to the influence of locality on the composition from the data at hand.

DIGESTIBILITY OF FEEDING STUFFS (pp. 86–88).—Partial data are given for tests of the digestibility of cotton-seed hulls and corn fodder by means of feeding experiments with cattle. Analyses are given of the cotton-seed hulls and the corn fodder fed.

COMPARATIVE ASH DETERMINATIONS, D. ADRIANCE, M. S. (p. 89).—This is a comparison on 16 samples of feeding stuffs of the percentage of ash obtained (1) by the official method for 1890, (2) by burning in a muffle furnace, and (3) by moistening the material with sulphuric acid and then burning over a direct flame. "The work clearly shows that the methods are comparable only in exceptional cases."

MISCELLANEOUS ANALYSES (pp. 89, 90).—Analyses of 6 samples of fertilizers, 1 sample of water, and 1 of roasted cotton seed.

Texas Station, Bulletin No. 16, June, 1891 (pp. 15).

WORK IN HORTICULTURE, S. A. BEACH, B. S. A. (pp. 93–105).—A brief preliminary report is given on experiments in tile drainage for potatoes, cabbages, and strawberries. The method of setting strawberry plants employed at the station is described. A number of foreign varieties of apples, peaches, pears, cherries, and ornamental trees and shrubs have been received from the collection of the Iowa Agricultural College for propagation and distribution in Texas. Brief descriptive notes on these varieties are compiled from the publications of the Iowa Station and College. The list of fruits on trial at the station, as given in this bulletin, includes 167 varieties of peaches, 68 of plums, 32 of cherries, and 113 of apples. The list of trees and shrubs which have been grown successfully during the past 2 years at the station includes 42 species of forest and shade trees, 17 of conifers, and 31 of shrubs and small trees.

Vermont Station, Bulletin No. 26, September, 1891 (pp. 23).

MAPLE SUGAR, W. W. COOKE, M. A., AND J. L. HILLS, B. S. (pp. 39–59).—This includes extracts from the act of Congress of October 1, 1890, giving the conditions under which the bounty on maple sugar will be paid by the National Government; the composition of maple sap; descriptions of the polariscope and the hydrometer, and of the methods of testing with these instruments and with the thermometer; methods of analysis used by the station; the percentages of sugar in samples of Vermont maple sirup at different times in the season, as determined at the station; the effect of stirring or granulating the sirup on the per cent of sugar; the effect of draining sugar; the quality of ordinary Vermont sugar; tables for determining the relative value of sirup according to the temperature of its boiling point; and a discussion of the relative profitableness of sirup and sugar. The following

table gives the relative value per gallon of sirup containing different percentages of sugar, as calculated by the authors:

Degrees Baumé hydrometer.	Specific gravity.	Degrees Brix hydrometer.	Approximate per cent of pure sugar.	Temperature of boiling point.	Weight per gallon.	Relative value per gallon.
				Degrees F.	*Pounds.*	
25	1.205	44.9	41	215.0	10.0	68
26	1.215	46.8	43	215.1	10.1	72
27	1.226	48.7	45	215.3	10.2	75
28	1.236	50.5	47	215.6	10.3	78
29	1.246	52.4	49	215.9	10.4	82
30	1.257	54.3	51	216.2	10.5	85
31	1.268	56.2	53	216.6	10.6	88
32	1.279	58.1	54	217.0	10.7	90
33	1.290	60.0	56	217.4	10.7	93
34	1.302	62.0	58	218.1	10.8	97
35	1.313	63.9	60	218.6	10.9	100
36	1.325	65.8	62	219.5	11.0	103
37	1.337	67 8	64	220.3	11.1	107
38	1.350	69.8	66	221.2	11.2	110
39	1.362	71.8	68	222.0	11.3	113
40	1.374	73.7	70	223.2	11.4	117
41	1.387	75.7	72	224.5	11.6	120
42	1.400	77.7	74	226.0	11.7	123
43	1.415	79.8	75	227.8	11.8	125
44	1.428	81.8	77	229.7	11.9	128
45	1.442	83.9	79	231.8	12.0	132
46	1.457	86.0	81	234.0	12.1	135
47	1.471	88.1	83	236.3	12.3	138
48	1.486	90.2	85	238.7	12.4	142

The per cents of sugar given above are calculated for a fairly good sirup. The relative values in the last column are based on these per cents, but will be nearly the same for all except the poorest of sirups. The relative value is made use of as follows: A weight of 11 pounds per gallon and 33° Baumé is taken as the standard. Dividing the weight of the sirup by 11 gives the number of standard gallons. Multiplying the price that is to be paid for 11-pound sirup by the relative value figure and dividing by 100 gives the price to be paid per standard gallon.

[The following are the general conclusions from the investigations at the station on maple sugar:]

(1) An accurate thermometer is the sugar maker's best guide in determining how to handle his sirup to make a sugar that will draw the bounty.

(2) When sap begins to boil its temperature is about 213° F.; as it boils down and becomes thicker the temperature at which it boils rises, until towards the end it may be 235°-240° F., or even as high as 245° F.

(3) If the sirup had nothing in it but sugar and water, at a temperature of 230° F. it would test 80°, and at 253° F. it would test 90°. A degree means 1 per cent of sugar.

(4) The sirup also contains mineral matter, malate of lime ("niter" or "sugar sand"), burnt sugar, and toward the end of the season various materials resembling glucose, due to the starting of the buds and the beginning of the summer's growth of the tree.

(5) These extra materials at the beginning of the season are about one sixteenth the weight of the sugar, and increase until in some very poor and black "last run" they may amount to 30 pounds for every 100 pounds of actual sugar present.

(6) Hence 100 pounds of a first-class sirup boiling at 228° F. instead of containing 80 pounds of sugar, contains about 75 pounds of sugar and enough of the other materials (5 pounds) to make up the 80 pounds, the other 20 pounds being water.

(7) Such a sirup will have to be heated to 231° F. and some more of the water driven off before it will contain 80 per cent of actual sugar, and to 243° F. to contain 90 per cent sugar.

(8) The more the impurities the higher the temperature to which the sirup will have to be heated.

(9) To make a sugar testing 80° by the polariscope, "first run" sirup will have to be heated to 233° F. The general run of good quality sirup through the most of the season will need to be heated to 235° F., and if it is a little dark, to 236° F. Toward the latter part of the season the temperature will need to be raised to 238° F., and the same should be done at any time when a sirup gets scorched or for any reason seems to be of poor quality. This is always on the supposition that the sirup is stirred until it grains, according to the ordinary custom in Vermont, before it is poured into the tubs or pails. If the malate of lime is not removed these temperatures will need to be raised 2°.

(10) The "last run" can not be made into a sugar testing 80°. This is always true after the buds start, and usually the case with the one or two runs next previous.

(11) A sugar containing 90 per cent of pure sugar can be made only from the best of sirup in the first half of the season. The sirup to make it will have to be heated to 242° F.

(12) The sirup that will make 100 pounds of sugar testing 80° and drawing a bounty of $1.75, will make 88 pounds of sugar testing 90° and drawing a bounty of $1.76, a loss of 12 pounds of sugar to gain one cent in bounty.

The 90° sugar will need to be sold at 1 cent a pound higher than the 80° to make up for the loss in weight. Hence do not try to make a 90° sugar for the sake of getting the 2 cents a pound bounty, unless you have a special market that will pay you at least 1 cent a pound extra for the hard sugar.

(13) A sirup boiling at 219° F. has a specific gravity of 1.325 and weighs just 11 pounds to the gallon. This will not granulate under ordinary conditions, but at 220° F. crystals of sugar will begin to form.

(14) A sirup weighing 11 pounds to the gallon will, if of good quality, make 8¼ pounds of sugar testing 80° and drawing a bounty of 15 cents, or 7½ pounds of sugar testing 90° and drawing the same bounty.

Wisconsin Station, Bulletin No. 28, July, 1891 (pp. 16).

CONSTRUCTION OF SILOS, F. H. KING.—This article is based on observations on 93 silos, "of which 70 are in Wisconsin, 6 in Michigan, 6 in Ohio, and 11 in Illinois. Of these, 67 are lined wholly or in part with wood; 10 are lathed, and plastered with water-lime; 14 are stone, grout, or brick, with cement facing; 2 are lined with metal, and 1 with tar paper."

Wood-lined silos.—Of the 67 silos lined wholly or in part with wood 34, or more than one half, showed some rotting at the time of the examination. The oldest of these silos have been filled only five seasons; 7 are rotting at the end of the second filling; and 1, which was relined at the end of 3 years, has the new lining rotting after a single year's use. This appears like a dark record for the wood-lined silos, but there is a brighter side when the subject is studied in detail.

We have found five varieties of wood lining now in use, as follows:

(1) A single layer of matched boards, in 2 silos. One of these is rotting where it comes against a beam in the barn and the other has been used 1 year only. In the latter the silage spoiled 1 foot in at the corners and from 2 to 4 inches on the sides.

(2) Two layers of common boards without paper and unpainted. But one of these was examined and this was rotting in several places after 3 years' service. The silage had spoiled to a considerable extent in it, but it should be said that it was built of cull boards, many of which were worm-eaten and even spongy in places.

(3) Two thicknesses of boards separated by strips of furring laid upon tar paper. Of the 6 silos containing this type of lining, their average age being 3.33 years, every one has rotted, 2 of them so badly as to require extensive repairs before the silos are suitable for service again.

(4) One thickness of matched boards with paper on the studding. Thirteen of these silos have been visited. 6 of which, with an average age of 3 years, are in good condition still, while 7, with an average age of 3.43 years, are rotting more or less.

(5) Two thicknesses of boards with paper between, nailed closely and firmly together. There are 45 of these silos, 26 with an average age of 3 years, in good condition, while 19, with an average of 3.4 years, are rotting to some extent.

The rotting in most of the cases noted is by no means general, and the conditions under which it has occurred may be thus stated: (1) Where there has been inadequate general ventilation, 8; (2) where stone walls have been faced with wood, 8; (3) where boards came against beams or sills, 12; (4) where spoiled silage is left piled against the boards, 4; (5) where dirt is piled against or lies behind the lining, 4.

I believe that the rotting in every case we have thus far observed in the walls of wood silos is attributable to imperfect ventilation, and that it might have been greatly delayed, if not entirely prevented, by different methods of construction.

The linings of wood silos have been painted in various ways to render them less liable to rot, as follows: (1) Paint of any kind, (2) with hot coal tar, (3) with coal tar dissolved in gasoline, (4) with hot coal tar mixed with pitch, (5) with pitch alone, (6) with linseed oil and red ocher, (7) with linseed oil alone.

As far as can be deduced from a study of the silos visited, there appears to be very little if any advantage derived from the use of the paints mentioned.

Painting may even hasten decay. Some antiseptic liquid might be used, but tests are required to determine what is a good preparation for this purpose.

Stone and grout silos.—We have examined 14 silos which are stone or grout and 25 which are stone or grout below and wood above. The masonry of nearly all of these silos is plastered with one or more coats of some variety of water lime or cement, and where the work is well done the great majority of the testimony goes to show that the silage in contact with the masonry is just as good or even better than against the wood. * * * While it is true that the acids of the silage decompose the cement of the stone silos, still the life of a single heavy coat, well put on and protected from frost, appears to be at least 10 years, and with a yearly whitewashing with pure cement, I have no doubt that a single coat of plastering might last 20 to 30 years.

Where the walls of stone silos have been left rough and uneven through insufficient pointing or not plastering them, the settling of the silage develops air spaces against the walls, which result in more or less silage spoiling; this fact coupled with another, viz, that the earlier stone silos were comparatively shallow, has been, in my judgment, the chief cause of unfavorable criticism of these structures. The only serious objection I can urge against a well-built stone silo is its relatively high first cost.

Silos lined with other materials.—The 10 lathed and plastered silos examined all showed cracks and the disintegrating effects of the acids in the silage. Serious objections to this kind of lining are stated.

At the station are 2 silos lined with metal, 1 with sheet iron and the other with roofing tin. They have each been in use 1 year, and in my judgment are not likely to prove satisfactory. None of the available metals are in themselves proof against the acids of the silo, and it is difficult to coat them in such a way as to entirely shut off the acids. * * *

I have seen but 1 paper-lined silo, and it is very unsatisfactory. * * *

The 2 shingled silos were in a fair state of preservation, and the silage is reported to have kept well in them. In these cases cull shingles had been used at 60 cents per thousand.

Such a lining is necessarily less perfect, and I believe not as lasting as plain

boards, and when good shingles are compared with good lumber the lumber is cheaper.

As a result of his observations and experience the author believes that the silo should be not less than 24 feet deep, and either round or as nearly square as practicable, because "these forms give the greatest capacity with the least amount of side exposure."

In the construction of silos careful attention should be paid to the area of surface exposed in feeding the silage. Silage wastes much more rapidly when fed from the sides than from the top, and since the most economical construction demands the largest possible feeding surface, it follows that the feeding should be, in general, from the top.

The proper horizontal area of the feeding pit depends upon the amount of silage fed daily and the rate at which silage becomes seriously injured when exposed. I have not been able to gather facts enough to settle this important point. The spoiling is certainly more rapid in the shallow than in the deep silos, and more rapid when corn or clover is put in whole than when cut, because it is impossible to feed the surface down as evenly and keep it as smooth. My impression is that the silage should be lowered at least 2 inches daily, and that 3 would be better. Taking 3 inches as the depth fed daily, 40 as the number of animals, 150 days as the feeding period, and 1.5 cubic feet as the amount fed to each animal daily, a round silo 17.5 feet inside diameter and 37 feet deep would be required. The same conditions would also be met by a round silo 22 feet inside diameter, 24 feet deep, with a partition through the center.

Where all the silage can be fed conveniently from one point and a large amount of silage must be stored, one silo with partitions is not only much cheaper but better than separate structures, because the additional corners can not admit air from the outside when the pits are full and the round silo with partitions makes less corners than the rectangular ones do.

Two-inch partitions give ample strength where the filling takes place on both sides at once; and if it is desired to fill one pit faster than the other, temporary braces may be placed in the empty pit and removed as it is filled. I believe that two thicknesses of boards with paper between make a better partition than the 2-inch plank, which appear to be more commonly used.

Whatever tends to the expulsion and exclusion of entangled air must conserve the silage, and whatever tends to leave or form cavities in which air can lodge in bulk, experience shows, leads to spoiled silage. Cross rods, overhanging ledges, and projecting stones should be avoided, as they hold up the silage, forming cavities into which air collects, enabling the molds to grow.

When the feeding of the silage does not begin very soon after the completion of the filling, a good covering lessens the waste. I have found the following practices in regard to covering:

(1) Some do not cover at all and have 6 to 12 inches of waste.

(2) Some have used straw with no gain and possibly greater loss.

(3) Many use green marsh hay, cut, and sometimes wet, with good results.

(4) A few use chaff with good results.

(5) One has used boards covered with 8 inches of dry earth, which is used afterwards in the stables as an absorbent. Silage keeps well.

(6) One used straw and weighted with stone with poor results.

(7) Some use cut marsh hay covered with plank, the cracks between planks covered with boards, and the whole weighted with stone. Little loss except at edges and corners.

(8) Others use a layer of cut straw, then boards, then tar paper and boards again. Keeps perfectly except at edges and corners.

(9) Still others have used first paper, and then boards, weighted with stone, with good results.

The testimony in regard to covering is quite discordant. Some claim good results with a given method, while with others it has failed. Some have good results one season and very different results another with the same method. We need much more positive knowledge on this point than is now available.

Nine of the silos examined have been infested by rats. * * * The surest safeguard against them appears to be covering the bottom of the silo with a layer of small stones or grout before the cement is applied. * * *

The general verdict is that the freezing, so far as silage is concerned, is more an inconvenience than serious loss. * * *

At present prices there is no available material on the market which can compare with wood in cheapness of first cost, and if a mode of construction can be devised which will insure permanency to the framework, and at the same time give an effective service of say 10 years to the lining, the essential demands of a material for silo building will be met by it.

[The following conditions essential to durability are stated:] Only sound and well-seasoned lumber should be used. * * * Wherever the conditions are for the rotting of silage there it is quite possible for the silo lining also to rot, as my observations have shown, and since ample depth insures better silage, it may also be expected to better preserve the lining. * * *

[Since silage is most apt to spoil in the corners of the silo, the round form of silo is deemed preferable.] Perfect ventilation on both sides of the lining is one of the first essentials to its preservation; hence horizontal studding and the placing of linings directly against beams or sills should be avoided as well as the lining of stone walls with wood.

Silo linings.—In the majority of cases the best results have been associated with the lining consisting of two layers of boards with tar paper between them, but it does not appear essential that either should be matched; they should be of uniform thickness, however, and the narrower widths are best. On account of the conditions which work for and against the rotting of linings I believe a still more effective and durable lining may be secured by painting both layers of boards on one side only with hot coal tar boiled until it is not sticky when cold. The tarred sides should be placed face to face in the silo, tar paper between them, and I would urge the painting of the paper with cold coal tar after it is in place, but no faster than the inner lining is put on. * * *

The sills.—These should rest on a good stone wall, well bedded in mortar after having their under sides and inner edges painted with coal tar, as described for the lining, and they should be everywhere at least 6 inches above the bottom of the silo inside and 8 inches above the earth outside.

The comparative expense of different kinds of lining for round silos is estimated. The following comparative calculations of the cost of rectangular and round silos are given:

Rectangular silo, 180 tons.

14x34 inside, 30 feet deep.

Foundation, 13.44 perch, at $1.20	$16.13
Studding, 2x12, 28 ft., 4,704 ft., at $20	94.08
Sills, etc., 2x10, 26 ft., 206 ft., at $19	4.94
Sills, etc., 2x10, 16 ft., 426 ft., at $14	5.96
Rafters, etc., 2x4, 20 ft., 400 ft., at $16	6.40
Roof boards, fencing, 450 ft., at $15	6.79
Shingles, 5 M., at $3	15.00
Drop siding, 8 inch, 2,779 ft., at $16	44.46
Lining, sur. fencing, 4,256 ft., at $15	63.84
Tar paper, 426 lbs., at 2 c	8.52
Coal tar, 1 barrel	4.50
Painting, 60 c. per square	15.00
Nails and hinges	10.00
Cementing bottom	5.00
18 ¾-inch bolts, 18 inches long	2.70
Carpenter labor at $3 per M., and board	41.16
Total	344.44

Round silo, 180 tons.

20 feet inside diameter, 30 feet deep.

Foundation, 7.5 perch, at $1.20	$9.00
Studs, 2x4, 14 and 16 ft., 1,491 ft., at $1	20.93
Rafters, 2x4, 12 ft., 208 ft., at $14	2.91
Roof boards, fencing, 500 ft., at $15	7.50
Shingles, 6 M., at $3	18.00
Siding rabbeted, 2,660 ft., at $23	61.18
Lining, fencing, ripped, 2,800 ft., at $18	50.40
Tar paper, 740 lbs., at 2 c	14.80
Coal tar, 1 barrel	4.50
Hardware	6.00
Painting, 60 c. per square	18.20
Cementing bottom	5.00
Carpenter labor at $3 per M., and board	33.17
Total	246.59

Details of construction are illustrated by four figures. The following suggestions regarding the repair of silos are taken from the bulletin:

The matter of ventilation is the first point requiring attention. This can be secured in most of the silos which have carefully constructed dead-air spaces, by removing the upper board next to the plate or by sawing out sections between each pair of studding. These openings may be covered with netting.

Where paper has been placed against the side of the barn and strips of furring used to carry the lining, I believe the best way will be to remove the lining, take off the strips of furring, and apply sound lining directly to the paper, putting on new paper where the old is injured.

Where stone walls have been faced with wood and the lining is rotting, the wood should all be removed and the wall plastered so as to be a little more than flush with the lining above, and those silos which have walls which set back under the lining above should be faced out flush. A jog outward into the silo below is often admissible but the reverse never.

Where only small patches of lining are rotting it may be best to cut out the rotting wood and paint the edges well with carbolic acid or creosote oil to kill the germs. Then fit in a block and nail over it a piece of tin and paint this with a coat of hot, thick coal tar.

Where dirt has been banked against the lining it should be removed and the bottom lowered enough to let the boards become dry when the silage is removed.

Rotting silage should not be allowed to remain in the silo. When it must be left for a time, it should be thrown into the center away from the walls.

The cases of rotting against sills and beams are the most difficult to meet. It is, of course, important to prevent the rotting from extending to the sills, and in some of the cases this may be done by providing ventilation behind the lining and then removing the lower 2 feet of lining, facing each stud with a wedge-shaped strip about an inch thick at the bottom, letting it extend downward across the sill. Then, when the lining is restored and the wall below made flush with it, the ventilation will help to protect both sill and lining.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 88 (NEW SERIES), SEPTEMBER, 1891 (pp. 441–518).—This includes a report on the condition of the cereals, potatoes, cotton, tobacco, sorghum, fruits, and the relative numbers and condition of fattening swine September 1; a brief history of the development of the Russian crop-reporting system, with a statement of wheat production in Russia; a review of the rye situation; a reference to the cause of the reduction of the price of cotton; a local record of prices 70 years ago; a statement concerning crop conditions in Indiana and Illinois; articles on the agriculture of Ecuador, South America, and on the People's Banks of Austria-Hungary; European crop report for September; notes on foreign agriculture; and rates of transportation companies.

Statistics of Russian wheat for 7 years.

Years.	Winter wheat.	Spring wheat.	Total.
	Bushels.	*Bushels.*	*Bushels.*
1883	54,788,053	172,004,515	226,792,568
1884	79,861,622	187,581,242	267,442,864
1885	77,228,474	100,855,926	178,084,400
1886	40,267,325	123,187,948	163,455,273
1887	98,881,512	179,816,405	278,697,917
1888	110,690,919	185,011,574	295,711,493
1889	41,742,626	136.740,826	178,483,452
Average	71,924,219	155,028,348	226,952,567

Statistics of Russian cereals and peas for 1890.

	Russia.		Poland.	
	Chetverts.	Bushels.	Chetverts.	Bushels.
Wheat (winter)	13,248,100	78,905,684	2,078,100	12,377,164
Wheat (spring)	22,510,900	134,074,920	44,300	263,851
Rye	113,065,700	673,419,309	7,632,400	45,458,574
Oats	90,813,900	540,887,588	6,042,000	35,986,152
Barley	27,896,400	166,172,958	2,059,100	12,264,000
Spelt	1,853.600	11,040,042	....	....
Buckwheat	7,760,800	46,223,825	524,300	3,122,731
Millet	9,015,600	53,696,914	178,900	1,065,528
Maize	4,068,700	24,233,177	....	....
Peas	2,580,500	15.369,458	886,700	5,281,185

BUREAU OF ANIMAL INDUSTRY.

CAUSE AND PREVENTION OF SWINE PLAGUE, T. SMITH (pp. 166, plates 12).—This is the second special report on the investigations of infectious swine diseases conducted by the Bureau, the first being on hog cholera (see Experiment Station Record, vol. I, p. 103). The present volume contains the details of investigations which have led to the differentiation of swine plague as a disease distinct from hog cholera. After a short introduction the subject is treated under the following heads: Brief description of the methods employed in the investigations; brief summary of the earlier investigations of swine plague (1886–88) in Illinois, Iowa, Maryland, and the District of Columbia; investigations of 1889–90 in the District of Columbia and New Jersey; swine-plague bacteria, general characters, and resistance to destructive agents; pathogenic action of swine-plague bacteria—(1) effect on small animals, (2) the disease in swine as produced by the inoculation of cultures, (3) swine plague as observed in epizoötics, (4) disease of the digestive tract in swine plague; attenuated swine-plague bacteria in sporadic cases of pneumonia, in septic diseases of swine, and in the upper air passages of healthy swine and other domesticated animals; other investigations of swine plague in America and Europe; practical observations—(1) conditions which may favor or oppose outbreaks, (2) distribution and transmission of swine-plague bacteria, (3) relation of hog cholera to swine plague, (4) relation of swine plague to diseases of other domesticated animals, (5) measures to be taken in the prevention of swine plague; conclusions; appendix—the presence of septic bacteria probably identical with those of swine plague in the upper air passages of domestic animals other than swine, by V. A. Moore.

The general conclusions from the investigations reported are thus stated:

(1) There are two independent infectious diseases of swine, swine plague and hog cholera, each caused by an easily recognizable, specific disease germ.

(2) Swine plague (in those outbreaks which have come to our notice) is limited chiefly to the lungs in its destructive effect. The intestines may be and frequently are involved in the disease process. Hence it is an infectious pneumo-enteritis rather than an infectious pneumonia.

(3) There is considerable variation in the virulence or disease-producing power of swine-plague bacteria from different outbreaks. The greater the virulence, other things being equal, the severer and more extensive the epizoötic.

(4) The bacteria of *Schweineseuche* (German disease of swine) are identical with those of swine plague.

(5) In the upper air passages of a certain percentage of healthy swine, cattle, dogs, and cats, bacteria exist which belong to the species of swine-plague bacteria, and which as a rule possess a relatively feeble virulence. While it is probable that such bacteria may produce disease it may be regarded as pretty certain that it is largely aided by secondary causes producing unthriftiness, and is merely sporadic and not communicable.

(6) In many epizoötics of swine disease both hog cholera and swine-plague bacteria, as well as the respective lesions of these bacteria, coexist. Such mixed diseases are

due to the frequent presence of both bacteria in the surroundings of swine, probably a result of frequent introduction. Either disease may be primary, according to its relative virulence.

(7) It is highly probable that the many attenuated varieties of either disease germ can produce disease only when assisted by the other germ or by the unsanitary, unphysiological methods of rearing swine, by which the latter are reduced in vitality and made more susceptible.

(8) It is pretty well established that there are a number of infectious diseases affecting cattle, buffaloes, deer, fowls, and smaller animals, the bacteria of which are closely related if not identical with those of swine plague. These plagues appear in various parts of the globe sporadically. (*Wild-und Rinderseuche, barbone bufalino,* fowl cholera, rabbit septicæmia.) Their tendency to spread from one species to another, from cattle to swine for instance, probably depends on the degree of virulence of the bacteria as well as the opportunities afforded for such transmission.

(9) Swine-plague bacteria are very probably introduced into a herd only in the bodies of animals, since they are speedily destroyed in soil and water by natural agencies. Virulent varieties are perhaps always derived from preëxisting disease. Attenuated varieties may be introduced by healthy animals. Since these may under special conditions give rise to disease, efforts to prevent and suppress infection must take into account the physical condition of the exposed animals.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

Reports of the Prussian experiment stations for 1890.—The following brief abstracts of the reports of the experiment stations in the Kingdom of Prussia are taken from the reports of the individual stations to the Prussian Minister of Agriculture, Domains, and Forests, as published in the *Landwirtschaftliche Jahrbücher, 20 (1891), sup. 1, pp. 6–74.* The original reports contain very few details, and in some cases consist merely of lists of the investigations carried on, which are of interest chiefly as indicating the lines of work pursued.

Bonn; Dr. A. Stutzer, director.—The analytical and seed-control work of this station included tests of 3,146 samples. The following scientific investigations were also carried on: (1) Studies of the rate of solubility of the digestible albuminoids of different foods and feeding stuffs in dilute hydrochloric acid and pepsin hydrochloric acid. The object was to determine whether when the mechanical hindrances to the action of the solvents were eliminated as far as possible, the digestible portion of albuminoids from different feeding stuffs would be dissolved with the same degree of rapidity in different cases. Considerable differences were noticed in this respect. For instance, of 100 parts of digestible albuminoids from cotton-seed meal and from peanut meal the following percentages were dissolved:

	Cotton seed meal	Peanut meal
	Per cent	*Per cent.*
By cold water	9	60
By pepsin solution acting for one half hour the solubility was increased to	62	98

The conclusion is that the protein of peanut meal is more easily digestible than that of cotton-seed meal. (2) On the changes in the digestibility of the albuminoids of foods and feeding stuffs caused by heating (see Experiment Station Record, vol. II, p. 527). (3) On the influence of common salt, of different organic acids, and of saccharin on the digestibility of albuminoids (see Experiment Station Record, vol. II, p. 525). (4) On the influence of fats and oils contained naturally in feeding stuffs on the digestibility of the albuminoid materials (see Experiment Station Record, vol. II, p. 529). (5) Field experiments with different varieties of oats, wheat, and rye made under the direction of the German Agricultural Society. (6) Experiments with a method for

determining the amount of fusel oil in spirits. It was found to be possible with the improved method to detect the presence of 0.01 per cent of fusel oil in spirits.

The author refers to the practical tests at the Göttingen Station (see p. 259) of the method of artificial digestion worked out under his direction, which throw new light on the determination of the digestibility of protein by artificial means.

Bremen; Prof. M. Fleischer, director.—In 1890, besides numerous analyses of fertilizers and feeding stuffs, the work included investigations of different moor soils, field experiments on moors, and vegetation experiments in pots, none of which are described.

Breslau; (1) *Experiment and Control Station; Prof. F. Holdefleiss, director.*—The analyses and examinations by this station included 3,854 samples of materials, among which were a large number of feeding stuffs, food materials, fertilizing materials, substances used for technical purposes, and soils. The feeding stuffs were as a rule not only analyzed but also examined microscopically with reference to purity and to condition (spoiled or not). Here, as at Posen (see below), rye bran was found to be very extensively adulterated not only with weeds, including some poisonous varieties, but also with all sorts of spores from rusts and blights of the grain, in some cases to such an extent as to render the bran unfit for food. Of the fertilizing materials bone meal and Thomas slag meal were more often found to be adulterated than any others. Ground bone was adulterated by replacing the gelatinous materials which had been removed by steaming, not only with horn, hair, and the like, but also with castor pomace.

Aside from the analytical work the following investigations have been carried on during the year: (1) Studies of bone and bone meal with a view to devising a means of judging of the various preparations of bone which occur in the market. The results of this work have been published by Dr. Holdefleiss in a pamphlet entitled *Das Knochenmehl, seine Beurtheilung und Verwendung;* (2) field experiments with potatoes and with different varieties of grain in different parts of the Province; (3) a critical study of the process employed by Chevalier Seeling von Saulenfels for removing the bitter taste of lupine.

(2) *The Station for Agricultural Botany and Seed Control; Dr. E. Eidam, director.*—During 1890 this station tested 1,905 samples of seeds and made various botanical examinations.

(3) *Institute for Animal Chemistry; Prof. H. Weiske, director.*—This is connected with the university at Breslau. In the experimental work the director is assisted by Dr. S. Gabriel. The work of the year included investigations in physiological chemistry and in animal nutrition, especially with reference to the digestibility of feeding stuffs.

Dahme; Prof. R. Ulbricht, director.—Besides chemical analyses and meteorological observations, the activity of this station has been along the following lines: (1) Pot experiments on the relative agricultural

value of phosphoric acid in different compounds and in different raw phosphates. The results of growing maize in unlimed moor soil, to which was added in separate instances 60, 120, and 240 kg. of phosphoric acid in the form of superphosphate, South Carolina phosphate, Lahn phosphorite, Norwegian apatite, and Kladno phosphate meal, indicated that the acid of the moor rendered the crude phosphorite valuable to the plants in a high degree. The results with 240 kg. of phosphoric acid in the form of Lahn phosphorite and 120 pounds in the form of South Carolina phosphate were practically the same. Similar experiments were made with barley grown in soil which had received a dressing of lime. These later experiments showed that the action of the raw phosphorite was less favorable in the limed than in the unlimed soil. (2) Experiments as to the fixation of free atmospheric nitrogen by papilionaceous plants. The results indicated very strongly that the vetches are to be classed with those plants capable of assimilating the nitrogen of the air. The experiments are to be continued. (3) Field experiments with the more important papilionaceous plants, to determine the amount of atmospheric nitrogen which the plant accumulates, and which in green manuring would be added to the soil. Owing to the large number of analyses necessary the results of these experiments have not yet been ascertained. (4) Field tests of *Vicia sepium*, *V. dumetorum*, etc. (5) Determination of the amount of mustard oil yielded by the seeds of cruciferæ and by rape cake. Twenty-eight samples of rape cake were tested. In most cases considerable amounts of this oil, up to 0.69 per cent, were found. (6) Investigations of the methods of determining phosphoric acid. The percentage of phosphoric acid in numerous samples of Thomas phosphate meal ranged from 15 to 23; two samples were found to contain Redonda phosphate.

The experiments on the above subjects will be continued in 1891, and in addition the following work is proposed: (1) Experiments to compare the agricultural value of the nitrogen in the forms of saltpeter and ammonium sulphate; (2) feeding experiments with pigs; (3) investigations as to the occurrence of gypsum, lime, and marls in the Province of Brandenburg, so far as they are of agricultural interest; (4) field experiments with the old and new varieties of potatoes, and (5) field experiments with maize.

Danzig; Dr. Güntz, chemical director.—The work of this station has consisted largely of analyses of various materials and examinations of seeds. In a large number of analyses of Thomas slag the highest percentage of phosphoric acid found was 21.69, the lowest 12.21; and 53.6 per cent of the determinations showed 18 per cent or over of phosphoric acid. In seven cases Redonda phosphate was found to be mixed with the slag meal.

Eldena; A. von Homeyer, director.—This is a control station, and its work during the year was confined to the fertilizer, feeding stuff, and seed controls, and the analysis of materials of interest to agriculture.

Geisenheim; Prof. H. Müller, director.—This station has made chemical studies on the composition of fruit wines, on the sugars in sweet fruits, on the sulphuric, sulphurous, and carbonic acids in wine, and on other matters relating to wine manufacture.

Göttingen; (1) *Agricultural Experiment Station; Prof. W. Henneberg,* director.*—The work of the year 1890 was in part a study of the constituents of feeding stuffs and in part studies, with the aid of the respiration apparatus, of the processes of the formation of fat and lean meat. The first experiment was with regard to the much discussed problem of the artificial digestion of protein, and was designed to settle the question as to the accuracy of the coefficients of digestibility of the protein in feeding stuffs, as determined by experiments in artificial digestion. The indications from these experiments were that the artificial digestion of protein is identical with the natural digestion, but since animals excrete considerable amounts of nitrogen-containing metabolic products, the natural digestion seems to give lower coefficients of digestibility than the artificial. If, then, a method can be devised for estimating the amount of these metabolic products the results of artificial digestion may be corrected for the natural digestion; and if the excretion of metabolic products is found to follow general rules, then it will become possible to calculate from the results obtained by artificial digestion the true coefficient of digestibility for the protein corresponding with the coefficient obtained in experiments on animals. On the basis of investigations commenced in Weende and continued for the past 3 years at Göttingen, a method for accurately determining these metabolic products has been perfected and the laws governing the excretion of these products have been worked out. According to the results obtained, for every 100 grams of dry matter digested 0.4 gram of nitrogen in the form of metabolic products is excreted, which at present is reckoned as undigested protein. Repeated experiments have shown the method to be reliable, but have indicated that the excretion of metabolic products is dependent upon two things, (1) the amount of dry matter digested, and (2) the amount of undigested dry matter in the food. The proportion of 0.4 part of metabolic nitrogen to 100 parts of digested dry matter is therefore not infallible, but applies in general where moderately concentrated feeding stuffs are used. The coefficients obtained by experiments in artificial digestion must therefore be recalculated to obtain results applying to animals. Thus the difference between the percentage (63 per cent) of the protein in dried diffusion chips said to be actually digested by ruminants and the coefficient (87 per cent) indicated by artificial digestion, is said to be fully explained by the metabolic products.

The results of an experiment on the digestibility of oat straw showed that the digestibility of the straw was very considerably increased by treatment with a solution of sodium hydrate, for while 47 per cent

* Died November 22, 1890; succeeded by Prof. F. Lehmann.

of the organic matter in the untreated straw was digested by animals, from 70.7 to 71.9 per cent was digested from treated straw. The experiments with regard to the nutritive value of cellulose, an account of which was given in Experiment Station Record, vol. II, p. 613, are referred to.

(2) *Control Station; Dr. Th. Pfeiffer, director.*—This station reports analyses and tests of 687 samples of fertilizing materials, feeding stuffs, foods, seeds, etc. Microscopic examinations have often been of service in detecting the adulteration of feeding stuffs. The addition to rice meal of so-called protein meal, a by-product from the manufacture of starch, was noticed to a considerable extent.

Halle; (1) Agricultural Institute of University; Prof. Julius Kühn, director.—Field experiments were made on the effect of the continued use of each of several methods of culture and of different fertilizing materials; on the means of combating the beet nematodes; and on the influence of root tubercles in the assimilation of nitrogen by leguminous plants. Tests of varieties of plants, experiments on the prevention of the loss of nitrogen from manures, and studies on the improvement of exact methods of field experimentation are also reported. Feeding experiments with milch cows are to be undertaken during 1891.

(2) *Agricultural-Chemical Experiment Station; Prof. M. Maercker, director.*—An abstract of the report of this station, which is under the auspices of the Central Agricultural Society of the Prussian Province of Saxony, was given in Experiment Station Record, vol. II, p. 759.

Hildesheim; Dr. Karl Müller, director.—The work of this station included critical examinations of 2,570 samples of artificial fertilizers, feeding stuffs, seeds, etc.

Insterburg; Dr. W. Hoffmeister, director.—Besides the detective and general analytical work of this station, scientific investigations have been carried on with a view to devising a method for the quantitative separation of the different forms of wood gum, cellulose, and incrusting substances, and studies have been made of the sugars formed from the different wood gums.

Kiel; (1) Agricultural Experiment Station; Prof. A. Emmerling, director of the agricultural-chemical division, and Dr. M. Schrodt, director of the dairy division.—The total number of samples examined in the chemical laboratory was 2,111, of which 1,176 were in connection with the fertilizer control and 347 in connection with the control of feeding stuffs. Experiments were also made on the determination of the fat in linseed cake, using an apparatus devised at the station for drying in a stream of illuminating gas; on the estimation of the percentage of horn in bone meal; on the changes in composition and the percentage of fat of freshly mown grasses; and a large number of grasses from the Province of Schleswig-Holstein were analyzed. The chemical division proposes in 1891 to carry on studies as follows: (1) Thorough microscopic and chemical investigations of the palm nut and the feeding

stuffs prepared from it; (2) on the estimation of fat in linseed cake; (3) on the behavior of fat toward animal charcoal.

The dairy division has made analytical studies of the morning's and evening's milk of ten cows and of the milk of different breeds; examinations of butter fat and of the percentage of water in Schleswig-Holstein butter, and experiments with the Danish hand-centrifuge. Of the 158 samples of milk sent to the station for analysis 18 were found to have been watered and 21 to have been partially skimmed or diluted with skim milk. Twenty-five per cent of the samples, therefore, were found to have been tampered with, and 11 others were suspected. It is proposed during the present year to make experiments on the determination of solids in milk; on the value of fluorine salts, especially sodium fluoride, as a milk and butter preservative; studies of the albuminoid materials in "stringy" milk; and feeding experiments with milch cows.

Among the investigations of the bacteriological division were studies of the use of pure cultures of bacteria in ripening cream. This use of pure cultures is analogous to their use in the manufacture of spirits, where their introduction has been attended with marked success. A preliminary experiment, made in February, 1890, was followed by encouraging results. More extensive experiments were then made to determine whether the project was practicable on a large scale and whether the pure cultures could be retained practically pure for any considerable length of time. The material for inoculation of the fresh cream was taken each time from the buttermilk of the previous churning, and it was found that in this way relatively pure cultures could be retained for about 14 days. In later experiments in a large creamery it was recommended to transplant the bacteria by using a small amount of the ripened cream, and this was found to work successfully. As to the possibility of eliminating numerous undesirable qualities of butter by the use of pure cultures of lactic-acid bacteria, tests which were made showed at once a favorable change in the quality of the butter, and indicated that these faults could be prevented by the use of pure cultures. The station has also distributed pure cultures, and in each case has requested that a report be made of the results of their use. In cases where the butter was oily, possessed a musty or an oily flavor ("beet taste"), or was generally poor, the use of these cultures has been attended by a marked improvement in aroma and quality of the butter. Several critical examinations of butter which possessed undesirable qualities, such as a decidedly oily consistence, a strong, acid flavor, and other disagreeable flavors, showed the presence of large quantities of yeasts and molds of various forms in every instance.

Studies of the causes of the formation of cavities in cheese indicated that this was due to bacteria which are capable of decomposing the milk sugar (and perhaps also the albuminoids) and thus evolving gases. The size of the cavities and the character of the gases depend upon

the form of bacteria present. An organism which caused a bitter taste in milk was isolated and studied. A chemical examination indicated that the bitter taste was not due to butyric acid, as has been stated, and it is suggested that it may be due rather to some intermediate products in the changes of the albuminoids.

The experiments on cheese, and the bacteriological-chemical investigations on the souring of cream and of slimy and stringy milk are to be continued in 1891, and new experiments are to be commenced on the process of ripening cheese.

(2) *Agricultural Institute of University; Dr. H. Rodewald, director.*—This seed control station examined 1,490 samples of seeds with reference to purity, germination, etc. Experiments are planned for 1891 on the effect of different conditions of humidity of the air on irregularities and difficulties in the germination of seeds.

Königsberg; (1) *Agricultural Experiment Station; Dr. G. Klien, chemical director.*—Examinations and analyses were made of 1,981 samples of fertilizing materials, feeding stuffs, seeds, dairy products, etc., and meteorological observations were taken. In 1889 Dr. Klien* made experiments which he believed pointed toward a direct transmission of the fat of food into the milk. The experiments were with goats. The food consisted of bran, to which an increasing amount of palm nut oil was added up to the limit to which the animal would consume it. The saponification equivalent of the milk fat increased from 233 to 241; the equivalent for the palm nut oil added to the food was 247. After feeding a normal ration for some time another trial was made in a similar manner, except that rape seed oil, having a saponification equivalent of 177, was added to the bran in place of palm nut oil. The saponification of the milk fat fell during this feeding to 216. The report for 1890 states that experiments on this subject have been continued, and that the results agree in general with those previously obtained.

Fish were also made the subject of feeding experiments to determine whether fish of prey could become accustomed to vegetable food in place of animal food, and if so to observe their condition on an exclusively vegetable diet. Repeated attempts to compel them to accept vegetable food were unsuccessful, even after a long starvation period.

Experiments were commenced in 1890 on the effect of different amounts of gypsum on the development of oat and barley plants. In these experiments the condition of the plants in soil poor in gypsum was compared with that of plants in soil mixtures containing 10, 25, and 50 per cent of gypsum, respectively, and in gypsum without soil, the other conditions as to fertilizers, etc., being the same in all cases. Measurements of the leaves showed, as had been previously found with clover, that the gypsum was favorable to a luxuriant leaf growth, the leaves of plants grown in the soils containing large amounts of gypsum being longer and broader than the others.

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*Jahresber. ü. Agr. Chem., 1890, p. 647.

The plan of 1891 includes studies of the roots of leguminous plants, culture experiments with six varieties of oats on twelve different farms, and a comparison of the agricultural value of the phosphoric acid in bone meal and in Thomas slag meal, for potatoes and oats.

(2) *Dairy Laboratory of the Agricultural Institute of the University; Prof. W. Fleischmann, director.*—At present the laboratory is mainly used for purposes of instruction. No report of investigations is given.

Marburg; Prof. Th. Dietrich, director.—The activity of the station has been confined very largely to the making of analyses, examinations of various materials, and tests of seeds, 3,910 samples of all kinds having been examined.

Münster; Prof. J. König, director.—The work at this station has been largely analytical, the number of samples of feeding stuffs, fertilizers, soils, seeds, etc., examined during the year being 3,748. The Alsatian and French iron ores are said to contain smaller amounts of phosphoric acid than the German, so that Thomas slag derived from these ores contains a lower percentage of phosphoric acid than the normal, that is, 17 per cent. These poorer grades were found in the market to a considerable extent at times. Phosphate meal with as low as 11 to 12 per cent of phosphoric acid is mentioned. The adulteration of Thomas slag was found to be very common, the adulterants noticed being Redonda phosphate meal, and a precipitate from phosphates of iron and alumina; other mineral phosphates, as Atlas phosphate, have also been used for adulteration. Redonda phosphate is said to consist largely of phosphate of alumina, and Atlas phosphate of phosphate of iron, the phosphoric acid being in both cases almost entirely insoluble in acetic acid, while about half the phosphoric acid of a genuine Thomas slag should be soluble in acetic acid. But it was not found possible to detect adulteration with these phosphates by the amount of phosphates of iron and alumina present, since Thomas slag contains normally more or less of these compounds.

Poppelsdorf; Prof. U. Kreusler, director.—The work of 1890 included the following subjects: (1) Investigations of certain nitrogen-free constituents of vegetable coloring matters; (2) the respiration and assimilation of plants; (3) the processes of decomposition accompanying fermentation, putrefaction, and decay, with special reference to nitrification and the gains or losses of nitrogen; (4) the value of grains grown under varying conditions, especially of wheat with reference to baking qualities; (5) the value of brushwood (*Holzreisig*) for feeding purposes; and (6) meteorological observations,

Posen; Dr. G. Loges, chemical director.—This station reports having made examinations of 1,624 samples of various materials, including about 800 of fertilizers, nearly 600 of feeding stuffs, 100 of seeds, etc. Numerous cases were noticed of adulteration of Thomas slag meal with Redonda phosphate, and less seldom with phosphorite. Of the 596 samples of feeding stuffs examined, 497 were tested as to purity and

quality. A surprising condition was noticed with regard to the rye and wheat bran offered for sale in the Province of Posen. Of the 174 samples of rye bran examined, only 21.6 per cent were found to be pure, that is free from adulteration with other materials, and even these were not always in a good and fresh condition; 68.2 per cent had received additions of rye chaff, 8.5 per cent sand or dirt (up to 18 per cent), and 18.2 per cent so much ergot that the bran was considered unsafe for feeding. Another adulterant used for rye bran was finely ground oat chaff, as large amounts of this material as 40 per cent being found in some cases. The oat chaff is said to contain only 1.3 per cent of protein and 0.3 per cent of fat. It was also sold alone under the name of "oat bran" at the price of other brans. The 58 samples of wheat bran examined were found to be somewhat better, 67.8 per cent of these being unadulterated; 28.5 per cent contained rye chaff; and 3.7 per cent admixtures of sand. It was observed in general that the coarser brans produced in the roller process were almost entirely free from adulteration, which would be more perceptible than in the case of finer material. The station has worked out a method for detecting the adulteration of Thomas meal, and separating the adulterants quantitatively, which is not described in detail in the report;* and has proved the reliability of a method worked out elsewhere for the determination of the free fatty acids in feeding stuffs.

The work outlined for the present year includes studies of feeding stuffs in connection with the investigations undertaken by the Association of German Stations, studies of the properties of hot and cold-pressed rape cake, soil investigations, and field experiments in coöperation with an agricultural society in the Province.

Proskau; Dr. P. Sorauer, director.—Several new investigations have been made during the year by Dr. Sorauer on plant diseases and plant physiology. The report enumerates the following subjects: (1) The difference in the behavior of the wounds of fruit trees pruned at different seasons of the year; (2) the symptomatic significance of intumescence; (3) studies of the canker occurring on the genus *Rubus*; (4) investigations of the parasitic growth causing a blight on cabbages and other *Cruciferæ*; and (5) certain diseases of the grapevine. In 1891 studies of the first two subjects are to be continued, and new ones undertaken on (1) the formation of gum by injured (diseased) plants as a result of the action of bacteria; (2) *Peronospora viticola* and the means of combating it; (3) trials of copper preparations for parasitic diseases; (4) the rusts of fruit trees; and (5) the effect of noxious gases and fumes on fruit trees.

Regenwalde; Prof. H. Birner, director.—In 1890 this station made examinations of 1,598 samples of seeds, fertilizers, feeding stuffs, oils, etc. In addition to this work three field experiments are reported as follows: (1) Experiments with six different varieties of potatoes to study the effect upon the yield and the starch content of tubers, of nitrate

*Deut. landw. Presse, 1890, p. 525.

of soda with and without superphosphate, and of barnyard manure. The beneficial effects of nitrate of soda were apparent with all the varieties. (2) Experiments as to the yield of yellow and blue lupine and serradella, both grass and stubble, under the most advantageous conditions, the results of which are not yet reported. (3) A comparison of sowing lupine broadcast and in drills. This experiment was made on eight plats, each 25 square meters in area, on four of which the seed was broadcasted at the rate of 175 pounds per acre, and on the other four drilled at the rate of 80 pounds per acre. The results showed that at the time of blooming 85.2 per cent of the seeds capable of germinating had produced plants where the seed was broadcasted and 92.4 per cent where the seed was drilled. In the laboratory studies were made (1) on the effects of adding kainit and carnallite to lime soils; (2) on the relation between the free fatty acids and the spoiling of feeding stuffs; (3) on the changes in finely ground feeding stuffs by long exposure to the air; (4) on the culture of the oil turnip and its value as a fodder plant; and (5) on the culture and composition of *Stachys tuberifera*. The results of these experiments have not yet been published. The investigations upon the changes in feeding stuffs showed, among other things, that by lying exposed to the air for 6 months linseed meal lost not less than 73 per cent of its fat.

Wiesbaden; Prof. H. Fresenius, director.—Five hundred and ninety-one analyses were made during the year, most of which were in connection with the control of fertilizers and feeding stuffs.

To the above reports of Prussian stations the reports for 1890 of the station at Rostock and the seed-testing station at Hohenheim are appended.

Rostock; Prof. R. Heinrich, director.—The number of analyses of various materials and tests of seeds made during 1890 was 4,877. Of these there were 730 samples of fertilizing materials, 45 per cent of which were Thomas slag. Adulterations of the latter with Redonda phosphate were noticed in 23 cases. Three separate cargoes of Thomas slag, imported direct from England, were each found by the author to contain Redonda phosphate. Of feeding stuffs 704 samples were analyzed, the larger part being of peanut and cotton-seed feeding stuffs.

Field experiments were made to determine the best time for applying nitrate of soda to winter and summer grains, the results showing that in general the nitrate should be applied just as the plant begins its vigorous growth but before it has commenced to shoot upwards. A comparison of the effects of different nitrogenous fertilizers for oats showed for the first year the following relative action as based on the best result at 100: Ammonium sulphate 100, ground meat 72, ground bone 65, ground leather 59, dried blood 58, and ground horn 33. The plats receiving nitrate of soda met with an accident, but the results up to that time appeared to be similar to those with ammonium sulphate. Feeding experiments were made with cows as to the effect of food on

the fat content of the milk, the results of which indicated an increase in both per cent and total amount of fat in the milk when cocoanut cake was fed as compared with peanut cake (see Experiment Station Record, vol. III, p. 67), and the experiments of the previous year to compare the effects of sesame cake and peanut cake for fattening young lambs, were concluded. No striking differences were observed between these two materials, but each year the results were slightly in favor of the sesame cake.

The station has also superintended during the past year a series of coöperative field experiments on forty different farms to study the requirements of the soils. The results were controlled at the station by means of pot experiments. In these trials large pots were filled with soil from each farm and the same kinds and amounts of manure were used and the same kinds of plants were grown as on the larger fields. These pot experiments, showing the effects of different fertilizers on the different soils, are said to have been of much interest and served as an object lesson to large numbers of farmers who visited the station.

Hohenheim; Seed-Testing Station; Prof. O. Kirchner, director.—During the year ending October 1, 1890, this station tested 836 samples, representing over 286,000 pounds of seed, of which 599 samples were of clovers, the red clover predominating. Plat experiments with red clover, which have been in progress since 1885, to observe the relative yield of clover from different countries, have indicated that in that climate varieties from central Europe (those from Germany, Austria, Styria, Bohemia, Hungary, Poland, and England) differ very little in desirability, provided they have not come originally from America or southern Europe (Italy, southern France, southern Hungary, etc.).

In similar plat experiments during 2 years with lucern from Italy, Hungary, Provence, Würtemberg, and America the largest total yields of green fodder from successive cuttings was with Italian lucern and the smallest from American. In 1889 the yield of the American was 54.33 per cent and in 1890, 47.55 per cent as large as the yield of the Italian. Where American seed was used about half the plants died out the first season. The author believes it to be undesirable that American seed be placed on their market, and warns farmers against sowing it. He states that equally unfavorable results have been obtained with American lucern seed in Switzerland and France.

Investigations as to the changes in feeding stuffs by souring in the silo, O. Kellner, Y. Kozai, and Y. Mori, reported by O. Kellner (*Landw. Vers. Stat., 39, pp. 105–114*).—Earlier investigations by the author and J. Sawano seemed to show that the decomposition of the nitrogenous constituents of feeding stuffs in the process of ensiling was, in some cases at least, accompanied by the formation of ammonia, which was partially or wholly driven off during the drying of the material for analysis. Experiments with white clover as to

the extent of this loss and its proportion to the total nitrogen lost, indicated that when the ammonia which escaped during the drying of the silage was taken into account the amount of nitrogen in the sour silage was approximately equal to that in the original material before ensiling; or in other words that in the fermentation of feeding stuffs containing much water under exclusion of air no perceptible loss of nitrogen occurs.

The present series of experiments were carried on with (1) *Imperata arundinacea*, (2) Italian rye grass, (3) buckwheat (upper part, in milk stage), (4) mulberry leaves, and (5) turnip leaves (Japanese Daikon), each of which was treated as follows: About 5 kg. of the fresh material, from which the coarser stems, etc., had been removed, was cut finely and mixed, and while one portion was dried and analyzed at once another portion was sealed air-tight in a large glass bottle and buried about 1 meter deep in the ground. From 7 to 7.5 months later the samples were taken out and weighed. They were all found to be well preserved and entirely free from mold. The percentage of acid (calculated for lactic acid) ranged from 1.25 (mulberry leaves) to 28.16 per cent (turnip leaves) in the dry matter. The nitrogen was determined directly, and after previous drying, in samples of the silage from each material. None of the original materials except the turnip leaves contained more than a trace of nitric acid; the latter contained 0.795 per cent of nitric acid in the dried leaves. A determination of the nitric acid in the silage from turnip leaves indicated only a trace. The nitric acid had therefore almost entirely disappeared during the souring process—a result which agrees with previous observations by the author on beet leaves.*

The results of the analyses of the different samples of silage are in direct accord with the results of the experiments with white clover, and lead the author to the following conclusions:

(1) The chemical processes during the souring of feeding stuffs under exclusion of air cause no perceptible loss of nitrogen as long as the material used is free from appreciable amounts of nitric acid.

(2) In preparing the silage for analysis by drying, ammonia is generated through dissociation of organic ammonia compounds. The loss by this means in these experiments varied from 3.2 (*Imperata*) to 23.3 per cent (buckwheat) of the total nitrogen in the original material.

Determinations were also made of the digestibility of the protein in each of the materials before and after ensiling, as indicated by Stutzer's modified method of artificial digestion. The tests of the silage included tests of dried silage and of that from which the acid had been extracted by digesting with absolute alcohol. It was found that in general the process of ensiling had not rendered the protein less soluble in the digestive solutions, and in some cases in which the original material contained much cellulose the solubility of the protein was even higher in the silage than in the original material.

*Landw. Vers. Stat., 26, p. 454.

To observe the effect which ensiling had on the digestibility of the albuminoids, the non-albuminoid nitrogen was determined in the fresh and in the ensiled materials. In every case except that of *Imperata* the percentage of the non-albuminoids in the total protein was much larger in the ensiled than in the fresh material, *i. e.* the decomposition of the albuminoid materials during ensiling was very considerable in the case of the feeding stuffs very much richer in nitrogen, but in the case of *Imperata* (1.54 per cent nitrogen) there was comparatively little change. Assuming the non-albuminoid nitrogen to be entirely digestible, it was found on calculation that the digestibility of the albuminoids had considerably decreased in ensiling wherever any considerable decomposition of the albuminoids had taken place (all except *Imperata*). It would seem that the more soluble and digestible portions of the albuminoids are attacked during the fermentation, so that the albuminoids in the silage possess a lower coefficient of digestibility.

The loss of valuable ingredients of hay by exposure to rain, A. Emmerling (*Landw. Wochenbl. f. Schleswig-Holstein, 1891, pp. 569–571*).—From unpublished experiments made at the experiment station at Kiel in 1883 and 1884, the author was led to believe that the loss of valuable ingredients of hay by exposure to rain was dependent upon the number of rainy days and the amount of rainfall; but similar experiments in 1891 did not support this view, the amount of loss being proportionally much in excess of that of 1883 and 1884. Since the average temperature of the air in 1891 was 68° F. as compared with 62° and 60° in 1883 and 1884, respectively, he reasons that the temperature of the air is also an important factor. The increased temperature would aid the solution of the ingredients in water as well as the fermentation. Grass which during the past season was exposed in cocks and in swaths for 18 days, on 9 of which rain fell, sustained the following losses in percentages of the original amount of ingredients in the hay dried without wetting:

Percentage of ingredients in hay lost by exposure to rain.

	In cocks.	In swaths.
	Per cent.	*Per cent.*
Loss of total dry matter	18.3	29.4
Loss of crude fat	31.0	41.0
Loss of crude protein	20.0	24.8
Loss of digestible protein	19.8	38.8
Loss of non albuminoid protein (amides)	9.6	12.2

The loss in cocks and in swaths was therefore approximately as 62 : 100. This agrees very nearly with the relative losses in 1884, where the loss in cocks was about two thirds of that in swaths.

Coöperative experiments with cereals under the auspices of the German Agricultural Society (*Sächs. landw. Zeitsch., 1891, pp. 324–326*).—At a recent meeting of the German Agricultural Society

Professor Liebscher of Göttingen presented the report of the coöperative field experiments with cereals carried out in different parts of Germany in 1890, under the auspices of the Society. Of 124 experiments made, 30 were with wheat, 32 with rye, and 62 with oats. Several of the experiment stations participated in these experiments.

The results, aside from those relating to the tests of varieties, were in brief as follows: (1) The weight of kernel is a characteristic for the variety, and all previous observations have failed to show any change in this weight from continued culture. (2) The percentage of chaff or husk in the total weight of the kernel is also a characteristic for the variety, but no very considerable differences have been noticed between the different varieties tested. (3) The proportion of grain to straw, on the contrary, is relatively little affected by the variety. (4) The protein content of oats is practically independent of the variety. (5) The protein content of oat kernels is influenced in an exceptionally high degree by the kind and condition of the soil; and soil and climate also affect the proportion of grain to straw. The protein content was found to follow the yield, being the largest on a rich soil where the yield was largest. Thus it was found that on an average 75 pounds of grain grown on a loam soil contained as much protein as 100 pounds of grain grown on a sandy soil. The proportion of kernels in the total yield was also found to be largest in crops grown on heavy soils, which, the author says, is contrary to the general belief. According to this, therefore, light soils not only give smaller total yields of oats, but a larger proportion of straw to kernels, which also contain relatively less protein.

EXPERIMENT STATION NOTES.

ALABAMA STATIONS.—D. Gillis, M. S., has been appointed director of the Southeast Alabama Station vice T. M. Watlington, B. S., resigned. R. E. Binford, M. A., has become director of the North Alabama Station vice C. L. Newman, B. S.

COLORADO COLLEGE AND STATION.—A two-story stone and brick building, to cost $9,000, is being erected for the use of the station as well as of the college. A forcing house to be used for experiments in horticulture is also being built, together with a residence for the professor in charge of the farm. Exhibits have been made at several State and county fairs in Colorado of live stock, grain, and other agricultural products from the station and its substations.

CONNECTICUT STORRS SCHOOL.—A. B. Peebles, B. S., formerly connected with the Michigan College and Station, has been appointed professor in chemistry at the Storrs Agricultural School vice J. R. Hutton, B. S., resigned.

IOWA WEATHER AND CROP SERVICE REPORT FOR 1890.—This is the first annual report under the State law, approved April 25, 1890, and includes historical data regarding meteorological observations and crop statistics in Iowa; a sketch of the physical geography of Iowa, by R. E. Call; an article on climatology of Iowa, which contains a number of tabulated summaries of meteorological observations covering a number of years; and notes on the weather and summaries of meteorological observations in 1890, at different stations in the State.

KENTUCKY COLLEGE AND STATION.—C. M. Mathews has been elected professor of horticulture and botany in the college and horticulturist to the station.

NEW YORK CORNELL STATION.—H. Snyder, B. S., assistant in chemistry, has accepted the position of chemist to the Minnesota Station. L. C. Corbett, B. S., has been appointed assistant in horticulture vice E. G. Lodemann, B. S., who has been made an instructor in the Cornell University.

OHIO STATION.—The people of Wayne County having at a special election ratified the proposal of the county commissioners to donate $85,000 for the purchase of land for the station, the board of control will select the farm, and after the erection of suitable buildings the station will be moved.

UTAH STATION.—In a trial in which one lot of horses was watered before feeding and another lot after feeding, the results favored the former practice.

QUEENSLAND.—Bulletin No. 10, August, 1891, of the Department of Agriculture, Brisbane, contains a report of agricultural conferences held at Maryborough, Rockhampton, and Bundaberg. The topics presented in papers and addresses were, Wheat and its Cultivation, R. Adams; Improvement of Seed, D. Clarke; Dairying, B. Jones; Dairying and Dairy Cattle, Professor Shelton; Some Reasons for the Non-Keeping Qualities of Butter and Cheese, P. McLean; The Orange Tree and its Profitable Culture, P. Biddles; Tobacco Growing, S. Lamb; Farming for Profit, Professor Shelton; Tobacco Growing, A. Jones; Fruit Culture, J. S. Edgar; Canning and Fruit Preserving, Professor Shelton; Silos and Silage, R. S. Archer; Grazing Farms for Profit, Mr. Beak; Insect Pests, Professor Shelton; How to Improve the Breed of Horses, J. M. Murray; Durham Cattle, Mr. Peberdy; Mixed Husbandry, Mr. O'Shanesy; Maize, V. Murray; Cultivation and Tillage, Professor Shelton; Flowers, Miss E. M. Young; Fruit and Fruit Growing, Mrs. Maunsell; Cultivation of Cane and Manufacture of

Sugar, A. Gibson; Vine Culture, W. Melville; Bee Culture, G. Kendall; Potato Culture, B. Workman; The Farm Home, P. McLean.

GERMANY.—Professor Moritz Fleischer, for many years director of the Moor Experiment Station at Bremen, has been appointed professor of chemistry in the agricultural high school at Berlin as successor to Professor Landolt, and will enter upon his duties this fall. He will retain the general direction of the Bremen Station, but the work carried on will be under the immediate supervision of Dr. H. Tacke, formerly first assistant.

Professor Fleischer has resigned the position of editor in chief of Biedermann's *Central-Blatt für Agrikulturchemie,* which he has occupied for 11 years, and will be succeeded by Dr. U. Kreusler, professor in the agricultural academy at Poppelsdorf.

Professor Leopold Just, director of the Agricultural-Botanical Experiment Station at Karlsruhe, died August 30, 1891, at the age of 50 years.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING OCTOBER, 1891.

DIVISION OF ENTOMOLOGY:

Periodical Bulletin, vol. IV, Nos. 1 and 2, October, 1891.—Insect Life.

WEATHER BUREAU:

Special Report, 1891.

DIVISION OF STATISTICS:

Report No. 89 (new series), October, 1891.—Condition of Crops; Yield of Grain per Acre; Freight Rates of Transportation Companies.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. II, No. 12, July, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING OCTOBER, 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ARIZONA:

Bulletin No. 2, September 15, 1891.—Notes on some of the Range Grasses of Arizona; Overstocking the Range.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:

Bulletin No. 94, September 23, 1891.—Composition of the Ramie Plant; Fertilizing Value of Greasewood.

GEORGIA EXPERIMENT STATION:

Bulletin No. 14, October, 1891.—Variety and Fertilizer Experiments with Oats; Variety Tests with Wheat; Variety Tests and Fertilizer Experiments with Vegetables.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 21, August, 1891.—Second Report on Fungicides for Stinking Smut of Wheat.

Bulletin No. 23, August, 1891.—Smuts of Sorghum; Corn Smut.

MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:

Annual report, part III, 1890.

Bulletin No. 3 (second series), September 1, 1890.—The Babcock Milk Test Adapted to Testing Cream.

MARYLAND AGRICULTURAL EXPERIMENT STATION:

Third Annual Report, 1890.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Bulletin No. 15, October, 1891.—Experiments in Greenhouse Heating; Special Fertilizers for Plants under Glass; Report on Varieties of Strawberries; Report on Varieties of Blackberries and Raspberries.

Meteorological Bulletin No. 33, September, 1891.

EXPERIMENT STATION OF MICHIGAN AGRICULTURAL COLLEGE:

Bulletin No. 75, July, 1891.—Fertilizer Analyses.

Bulletin No. 76, October, 1891.—Kerosene Emulsion.

NEW JERSEY STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 83, September 15, 1891.—Analyses and Valuations of Complete Fertilizers.

NEW YORK AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 33 (new series), July, 1891.—The New York State Fertilizer Control and Fertilizer Analyses.

Bulletin No. 34 (new series), August, 1891.—Comparison of Dairy Breeds of Cattle with Reference to Production of Butter.

Bulletin No. 35 (new series), August, 1891.—Some of the most Common Fungi and Insects, with Preventives.

Bulletin No. 36 (new series), September, 1891.—Small Fruits.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 31, September, 1891.—The Forcing of English Cucumbers.
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 78*a*, July, 1891.—Meteorological Summary for North Carolina, April and May, 1891.
Bulletin No. 79*a*, August 15, 1891.—Meteorological Summary for North Carolina, June and July, 1891.
OHIO AGRICULTURAL EXPERIMENT STATION:
Bulletin vol. IV, No. 5, September 1, 1891.—The Wheat Midge.
RHODE ISLAND STATE AGRICULTURAL EXPERIMENT STATION:
Third Annual Report, part II, 1890.
Bulletin No. 11, June, 1891.—Fertilizer Law, Valuations and Analyses; Meteorological Summary.
SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 1 (new series), July, 1891.—Commercial Fertilizers.
TENNESSEE AGRICULTURAL EXPERIMENT STATION:
Bulletin vol. IV, No. 3, July, 1891.—The True Bugs of Tennessee.
TEXAS AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 17, August, 1891.—General Information Relating to the Texas Station.
AGRICULTURAL EXPERIMENT STATION OF UTAH:
Bulletin No. 8, August, 1891.—Silage.
VERMONT STATE AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 26, September, 1891.—Maple sugar.

DOMINION OF CANADA.

DEPARTMENT OF AGRICULTURE:
Annual Report for the Province of Ontario, 1890.

EXPERIMENT STATION RECORD.

Vol. III. ISSUED DECEMBER, 1891. No. 5.

EDITORIAL NOTES.

To obviate the difficulties met with in field experiments, various methods have been suggested. The chief aim has been to bring as many conditions as possible under the control of the experimenter and to eliminate those irregularities of soil, moisture, and plant food which often vitiate the results of field experiments. For this purpose use has been made of small quantities of soil placed in pots or boxes or in small plats separated by partition walls sunk in the ground.

The leading representative of this tendency of experimental inquiry just now is Prof. P. Wagner, of the experiment station at Darmstadt, whose methods of experimenting with soil in pots have proven most useful and are coming to be widely adopted. Wagner's system consists essentially in using cylindrical pots of zinc to hold the soil, which is carefully prepared and thoroughly mixed so as to have the portions in the different pots as nearly alike as possible. Any desired soil can be used. The pots are placed on small platform cars which run on rails, are easily moved, and can be put under shelter when necessary to protect the plants from rain, hail, severe wind, or frost. To regulate the water supply, the pots are weighed by a convenient apparatus, and water is added as often as is necessary to maintain the percentage of moisture in the soil best fitted for the growth of the plants. Wagner also uses larger cylinders set in the soil. In these the water supply can not be regulated so well, nor can the plants be put under shelter.

Noteworthy as is the success of the system which Wagner has been elaborating for more than a decade, a success proven by his own results and confirmed by the experience of others who have followed his method, it does not meet all the needs, and other experimenters are trying to improve upon it. The plan of inclosing the soil in boxes, which was undertaken over a score of years ago by Wolff and Henneberg and has been prosecuted by Hanamann, Lawes and Gilbert, Wohltmann, and others, has several advantages over that of pot experiments. Larger quantities of soil are used so that more plants may be grown. The plants

have opportunity for more natural root development. The temperature of the soil in the boxes is subject to less fluctuations than in the small pots, and is more like that of the soil in its natural state. The conditions of growth are thus more nearly normal. With proper appliances the water supply can be kept under control, the water table maintained at any desired level, the drainage water collected, measured, and analyzed, and thus the statistics of income and outgo of water and plant food can be determined.

Plans of box experiments adopted in the experimental garden of the Agricultural Institute of the University of Halle by Dr. Wohltmann, and at the newly organized Experiment Station for Plant Culture in Dresden by Dr. Steglich, are given on pages 342–354 of the present number of the Record.

By this method many of the difficulties of field experimenting are avoided, most of its advantages are retained, and a number of very desirable features are added. The experiments are close at hand and more easily watched than in a distant field. Any desired soil or selection of soils can be used. Each soil can be carefully prepared, sifted free from stones, and thoroughly mixed, so that it shall be alike in all the boxes. The boxes are set in the ground and plants are grown in the spaces between them. We thus have a series of experimental plats, as in a field experiment, only on a smaller and more convenient scale. Each plat is entirely isolated, so that the plants of one plat can not feed upon the material of another, and is large enough for a number of plants to grow upon it and small enough to be managed with little labor. There are tubes for watering the soil from below and collecting the drainage water. The water supply can be regulated at will and made the same for all. Thus drouth and excessive moisture, which injure or ruin so many experiments in the field, are prevented, and two chief sources of error in field experiments—unevenness of soil and inequality of water supply in the different plats—are avoided. Data for the statistics of water supply and removal are found in the measurements of rainfall, water applied artificially, and drainage. Analyses of drainage water show the amounts of plant food removed thereby. These, with weights and analyses of soil, fertilizers, and crops, supply the statistics of gain and loss of the elements of plant food. The plants can be more easily cared for and better protected from depredations of animals and from disease than in field experiments. The quantities of produce are so small that the plants and their several parts can be easily measured, and can be weighed and analyzed with comparatively little labor. In short, this is a sort of field laboratory. It is a device for applying to field experimenting the accuracy of method and convenience of manipulation which are indispensable for the best success.

A method of field experimenting which has a number of the advantages of the box experiment, has been adopted at the Dresden Station and is described on pages 350, 351. Small plats are used. These are made

uniform by careful attention to the subsoil and thorough mixing of the surface soil. Soils of several kinds are tested side by side for comparison. The plan consists in removing the soil to the depth of a meter (39.3 inches) and replacing it by the soil chosen for the experiment, which may be brought from a distance. For the experiments now being planned at this station typical specimens of five of the most important kinds of soil in Saxony have been selected. These are placed in position so as to provide small fields of different typical soils side by side. Each field is divided into narrow plats about 4 square rods in area. The plats of each field are uniform in respect to physical and chemical characters of the soil, and if the subsoil is uniform in its water supply and drainage, as is supposed, they will all have the same quantities of water. The uniformity of soil and water supply makes these small plats better than large ones ordinarily are. The quantity of water can not be regulated as in the box experiments, nor can the statistics of income and outgo of plant food and water be determined.

Of course such arrangements as these are expensive. In Dresden, where labor is somewhat cheaper than in most places in the United States, the plant for twenty experimental boxes complete cost about $1,000. That for the same number of small plats prepared as above described, cost from $750 to three or four times as much, according to the expense of getting, preparing, and especially transporting the large quantities of soil. But if the expense is considerable at the outset the work of carrying on the experiment is less than in ordinary field experiments, because everything is conveniently at hand and the areas are small.

For its box experiments the Dresden Station is planning a study of the acquisition of atmospheric nitrogen by plants and soils. While the affiliated station at Tharand is investigating the action of bacteria in the assimilation of the nitrogen of the air by plants grown in artificial soil, the Dresden Station is to study the practical side of the subject by experiments in natural soil, so devised that the gain and loss of nitrogen may be accurately determined. To this end boxes are to be filled with soils of different kinds and lupines grown in them. Some will be treated with bacteria from soils in which lupines have been successfully cultivated, and thus the effects of the inoculation will be observed. Accurate account is to be kept of the amounts of nitrogen in the soil at the outset, the amounts removed by drainage water and in the plants that are harvested, and the amounts left in the soil at the end of the experiment, which is to last several years. The balance will show how much nitrogen the soil and plants have gained by the different treatments.—[W. O. A.]

The following information regarding experiment stations in Java has been furnished by Dr. H. Winter, for some time chemist of the West Java Sugar Experiment Station and later connected with the station in Middle Java. Though not statistically complete, it is nevertheless of interest as illustrating the progress of the experiment station enterprise there.

There are at present four experiment stations on the Island of Java. Three, which may be called sugar experiment stations, were organized and are supported by associations of sugar producers. The fourth, which is supported by the Government, is connected with the botanical garden at Buitenzorg, and is devoted to investigations of tropical plants, especially those of commercial importance in Java.

Of the three sugar experiment stations, one is situated at Kagok Tegal in West Java, another at Samarang in Middle Java, and the third at Passoeroean in East Java. The oldest is the West Java Station, which was founded in 1885. It is under the control of an association of some thirty or forty sugar producers, who furnish the means for its support—about $16,000 annually—and appoint a committee from their number for its management. Every associate pays in proportion to the area he cultivates. At the time of its organization the working staff included a director, Dr. W. Krüger, and a chemist. The present director is Dr. Went.

Some of the results of the investigations at this station have been reported by Dr. Krüger in Dutch and also in German in a volume entitled *Berichte der Versuchs-Station für Zuckerrohr in West Java, Kagok-Tegal (Java)*, published in Dresden, Germany, in 1890. It contains accounts of three investigations by Dr. Winter and one by Dr. Krüger. Of those by Dr. Winter, the first, on Methods of Investigation for the Cane-Sugar Industry, describes studies on the determination of glucose in sugar juices, the determination of sugar in sugar cane, and the selection and investigation of average samples in field experiments; the second, on The Chemical Composition of Sugar Cane, treats of the distribution of sugar in sugar cane and the chemical constituents of sugar cane; the third, on Extraction of Cane Sugar from Sugar Cane, contains articles on certain materials which appear in the making of sugar, and on lime precipitation (without CO_2). That by Dr. Krüger is on Diseases and Enemies of the Sugar Cane, and is in three divisions. The first, on diseases due to animal parasites, treats of diseases caused by borers and *Physopoda*; the second, on diseases due to vegetable parasites, treats of blight, red spot of the leaves, rust, and a disease of the leaves caused by a sclerotium; the third treats of obscure diseases probably due to vegetable organisms. Among the nine plates accompanying the text are illustrations of *Scirpophaga intacta*; *Chilo infuscatellus*; *Diatræa striatalis*; *Grapholitha schistaceana*; *Thrips sacchari*, n. sp.; *Phlœothrips lucasseni*, n. sp.; *Tylenchus sacchari*; *Cercospora köpkei*, n. sp.; *Ustilago sacchari* (?), and *Uromyces kühnii*, n. sp.

A few months after the establishment of the West Java Station a second, similar in organization and purpose, was founded at Samarang, Middle Java. The members of the association which controls it contribute to its support in proportion to the amount of sugar produced each year. Its income averages about $20,000 per annum. It was first organized with Dr. Benecke, a botanist, as director, and a chemist as assistant. In connection with the station work there was also a course of instruction to about a dozen students.

The third sugar experiment station was started in 1886, in Passoeroean, East Java, on essentially the same plan as the one in West Java. Its income is over $24,000 per annum. The working staff includes Dr. Kramers as director and chemist, a vice director and botanist, a bacteriologist, and an assistant chemist. For manual services four helpers are generally employed.

The institutions mentioned above are working exclusively in the interest of the production of cane sugar, and are only in this limited sense agricultural experiment stations. The latter designation may, however, be properly applied to the station connected with the botanical garden of Buitenzorg. Its work is principally botanical, and, as above stated, it has to do with tropical plants, the development of which is so important in Java. Extensive investigations have been made with fertilizers at this as at the other stations, but their success has been interfered with by diseases which have attacked the plants.

It is probable that other stations will soon be organized in the interests of the production of coffee, quinine, tobacco, etc., and one especially for indigo.

The management of the stations is liberal. The buildings, especially the laboratories, are very substantial, and are provided with water, gas, and other conveniences. The equipments for the particular lines of investigations are excellent. The salaries are generous—$5,000 per year for directors, $2,500 to $3,750 for chemists, and $1,500 for assistants.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Arizona Station, Bulletin No. 2, September 15, 1891 (pp. 12).

NOTES ON SOME OF THE RANGE GRASSES OF ARIZONA, J. W. TOUMEY, B. S.—This is a brief preliminary report on some of the most important grasses growing on the open mesa lands, in valleys, and on mountains. The species mentioned in the bulletin are *Bouteloua eriopoda*, *B. oligostachya*, *B. racemosa*, *B. hirsuta*, *B. aristidoides*, *B. harvardii*, *Buchloe dactyloides*, *Hilaria mutica*, *H. jamesii*, *H. rigida*, *Aristida arizonica*, *A. purpurea*, *Pappophorium laguroideum*, *Panicum lachnanthum*, *P. bulbosum*, and *Muhlenbergia distichophylla*. Attention is called to the diminution of the pasturage on the ranges, due to overstocking. The close pasturing of the native grasses, combined with drouth, is causing the gradual extinction of the more valuable forage plants on many of the ranges.

Arkansas Station, Third Annual Report, 1890 (pp. 155).

FINANCIAL STATEMENT (p. 4).—An itemized account of expenditures by the station in 1890.

SHRINKAGE IN SILAGE (p. 5).—A brief tabulated statement of the amount of corn and sorghum stored in and of the silage taken from the station silo.

EXPERIMENTS WITH CORN, POTATOES, GRASSES, AND SUGAR BEETS (pp. 5–12).—*Corn after rye* (p. 5).—A brief tabulated record of the amount of rye and corn obtained from ten plats on which rye was harvested at different dates from April 9 to May 12, inclusive, and was followed by corn.

Corn, test of varieties (pp. 6, 7).—Tabulated data for 41 varieties grown in 1890. The results of 3 years' experiments indicate that White Giant Normandy, a late variety, is best suited to northwestern Arkansas.

Corn, fertilizer experiment (p. 8).—Tabulated data for twelve plats of sandy soil, on which cotton-seed meal, acid phosphate, and kainit, in different combinations, were compared with no manure for White Giant Normandy corn. The best results were obtained with cotton-seed meal combined with acid phosphate.

Potatoes, fertilizer experiment (p. 9).—A brief tabulated record of an experiment in which different fertilizers were compared with no manure on seventeen plats where early potatoes were planted by the trench method. The highest yield was with a combination of acid phosphate, kainit, and dried blood.

Grasses and forage plants (p. 10).—A tabulated record of the condition December 8, 1890, of 26 species of grasses and forage plants sown on thin, sandy soil at the station in the spring of the same year. Japan clover is the only kind reported in good condition.

Sugar-beet experiments (pp. 11, 12).—A brief tabulated record of the yields of 13 varieties of sugar beets, and of American Imperial sugar beet on sixteen plats where different amounts of cotton-seed meal, acid phosphate, and kainit, singly and two by two, were compared with no manure. The highest yield, 13,280 pounds per acre, was with 50 pounds of acid phosphate.

REPORT OF CHEMIST, G. L. TELLER, B. S. (pp. 13–28).—The author entered upon the duties of his office September 20, 1890, succeeding C. B. Collingwood, B. S. The report includes notes and tabulated data on analyses of sorghum, sugar beets, and fertilizers.

Sorghum analyses.—The work on sorghum during 1890 comprised a complete analysis of 352 samples of juice, besides a partial analysis of 225 other samples, made in connection with (1) an experiment to study the effect of fertilizers on the yield of sugar, (2) a test of varieties, and (3) an examination of juice as an index to the selection of seed.

Effect of fertilizers on yield of sugar.—Kainit, acid phosphate, and cotton-seed meal in different amounts and combinations were compared with no manure on 40 fiftieth-acre plats planted with Early Orange sorghum. The highest per cent of sucrose was obtained when the three fertilizers were combined, and in general the application of kainit seems to have had "a beneficial influence upon the amount of sugar in the canes and juice." This is in agreement with the results of a similar experiment reported in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 317).

Test of varieties.—A tabulated record of analyses of 18 varieties. "In nearly every case the degree Brix of the juices analyzed here is lower than in that of the cane from which the seed was selected. All of the varieties polarized on an average more than 14 per cent of sugar. Of the 6 varieties the juices of which showed more than 15 per cent of sugar, all but one (Link Hybrid) were said to be crosses. The same varieties show a relatively high purity coefficient."

Sugar-beet experiments.—Tabulated analyses are given of samples of beets grown in the experiment referred to above. In only one case (White Imperial 11.8 per cent) was the per cent of sucrose in the juice above 9 per cent.

Fertilizer analyses.—Analyses of 6 samples of commercial fertilizers.

REPORT OF HORTICULTURIST, J. MCNEIL, B. S. (pp. 29–61).—A report of experiments with tomatoes, cucumbers, apples, strawberries, plums, apricots, and grapes.

Tomatoes (pp. 29–31).—Nitrate of soda, kainit, acid phosphate, and cotton-seed meal were applied to Paragon tomatoes. The largest and most profitable yield (528 bushels per acre) was in the row fertilized with 800 pounds of nitrate of soda per acre.

Cucumbers (pp. 32, 33).—The yields are reported for 13 varieties of cucumbers, planted in hills in the ordinary way and around a pit filled with stable manure. The aggregate yield favors the latter method of planting, but 5 of the varieties did better when planted in the ordinary way.

Apples (pp. 33–38).—A list is given of 110 varieties, together with 16 of crab apples, growing in the station orchard. An experiment is described in which apples were kept in a storehouse, the temperature of which was kept between 40° and 50° F. by the use of ice. The profit, as estimated, was sufficient to warrant the repetition of the experiment. Apples dipped in hot paraffin did not keep any better than those left untreated.

Strawberries (pp. 39–45).—A reprint of Bulletin No. 13 of the station (see Experiment Station Record, vol. II, p. 198).

Plums and apricots (p. 46).—A brief note on the condition of the varieties of plums and apricots growing at the station.

Grapes (pp. 46–61).—Tabulated data for 138 varieties planted in the spring of 1888 and fruiting for the first time in 1890. The yield, with few exceptions, was poor. This is attributed to the following causes: "(1) The evident unfitness of many of the varieties for this locality, (2) the prevalence of rot, (3) the depredations of the grape leaf folder, and (4) the unfavorable situation of the vineyard."

A NEW INSECTICIDE FOR THE COTTON WORM, A. E. MENKE, D. Sc., AND G. C. DAVIS (pp. 62–69).—A reprint of Bulletin No. 15 of the station (see Experiment Station Record, vol. II, p. 318).

REPORT OF ENTOMOLOGIST, C. W. WOODWORTH, M. S. (pp. 70–97, figs. 2).—Brief notes are given on the following insects which injured crops in Arkansas in 1890: Cutworms, white grub, grain plant louse, grape leaf folder, cotton worm, and bollworm. Great differences in the amount of injury to the foliage of different varieties of grapes by the grape leaf folder were observed. Hybrid varieties were especially attractive to the worm, while those of the species Vulpina suffered comparatively little injury. An article on cotton worms is reprinted from Bulletin No. 12 of the station (see Experiment Station Record, vol. II, p. 198) and another on the effects of arsenites on plants from Bulletin No. 14 of the station (see Experiment Station Record, vol. II, p. 198). Some additional notes are inserted in the latter article with reference to the relation between the strength of the poison used and the injury produced, and the differences in the amount of injury due to differences in

the time of application. The following tables contain a summary of experiments in which the arsenites were used in the proportion of 1 part by weight to 100 or more parts of water:

A series of 240 experiments on the oak gave the following results:

Percentages of injury to oak leaves.

Poison used.	1-100	1-200	1-400	1-600	1-800	1-1000
Fresh white arsenic	32	25	7	3	6	2
Old white arsenic	100	100	100	100	99	99
Paris green	100	100	100	90	97	92
London purple	93	91	80	34	44	25

A series of 320 experiments on the tomato gave the following data:

Percentages of injury to tomato leaves.

Poison used.	1-100	1-200	1-400	1-800	1-1600	1-3200	1-6400	1-12800
Fresh white arsenic	0	0	0	0	0	0	0	0
Old white arsenic	*100	*100	*100	*100	100	100	100	1
Paris green	*100	*100	*100	*100	*100	*100	*159	3
London purple	*100	*100	*100	*100	*100	3	1	0

*Stems also killed.

To determine how much difference is due to the time of application 216 applications were made on apple, grape, and peach leaves, care being taken to make the applications entirely parallel as to number, age of leaf, and method of application.

Percentages of injury to apple, grape, and peach leaves.

Poison used.	First day.	Second day.	Third day.	Fourth day.
White arsenic	14	58	51	9
Paris green	52	36	27	15
London purple	67	60	58	30

These applications were all made during 1 month, so that they probably show only the effects of the different atmospheric conditions. * * * It seems very evident that the condition of the leaf, which is dependent upon the atmospheric condition at the time, is the chief cause of this variation. The fact that poison applied dry and kept dry can be applied in almost any quantity to a plant without injury would prove that the critical time is dependent upon the period of application and subsequent rains and dews. Leaves do not have the same power to absorb moisture at all times.

REPORT OF VETERINARIAN, R. R. DINWIDDIE, V. S. (pp. 98–122, figs. 4).—This contains an account of investigations of Southern cattle plague by the author. Reference is made to experiments published in Bulletin No. 11 of the Missouri Station (see Experiment Station Record, vol. II, p. 160) and Bulletins Nos. 7, 8, 9, and 10 of the Nebraska Station (see Experiment Station Record, vol. I, p. 123). Experiments by the author in the preventive inoculation of cattle in Arkansas and

in the cultivation and production of the disease by inoculations from different organs of diseased cattle and the manure of Southern cattle, gave negative results. Further experiments failed to show any particular bacterium as the cause of the disease. The intracorpuscular bodies, first described by Dr. T. Smith of the Bureau of Animal Industry of this Department, were observed by the author in materials from the spleen and kidneys.

EXPERIMENTS WITH SWEET POTATOES, R. L. BENNETT, B. S. (pp. 123–128).—These were at the branch station at Newport, Arkansas. The yields of 9 varieties tested on sandy soil in 1890 are given, together with a tabulated record of the chemical composition of the tubers and vines of the varieties tested, as determined by the station chemist, and brief tabulated records of experiments with fertilizers, on high *vs.* low culture, and on the effect of the removal of the vines on the yield of tubers. The best results were obtained in the use of kainit and low culture. The yield decreased 44.5 bushels per acre where the vines were removed.

EXPERIMENTS WITH GRASSES AND LEGUMES, R. L. BENNETT, B. S. (pp. 129, 130).—A brief account of 2 years' tests of 33 varieties of grasses and legumes on the sandy soil of the branch station at Newport. None of the plants tested could be profitably grown for hay without a liberal use of fertilizers. "Orchard grass, timothy, tall fescue, tall meadow oat grass, Kentucky blue grass, alfalfa, redtop, meadow fescue, and Bermuda grass having succeeded better than others, are being further experimented with by the application of fertilizers."

FIELD PEAS, R. L. BENNETT, B. S. (pp. 130–133).—Brief notes on 9 varieties of peas, and a table showing the comparative feeding values of pea hay, timothy hay, and millet.

FEEDING EXPERIMENT WITH STEERS, R. L. BENNETT, B. S., AND A. E. MENKE, D. SC. (pp. 134–146).—The chief object of this experiment was "to determine the effects, if any, of cotton-seed products, variously combined, upon the quality of the flesh and fat" when used for fattening animals for beef. Eleven range steers, from 2 to 2½ years old, and varying in weight from 560 to 792 pounds, were fed in stalls for a period of 90 days, as follows:

Lot 1, cotton-seed meal and cotton-seed hulls.

Lot 2, corn and pea-vine hay.

Lot 3, cotton-seed meal, cotton-seed hulls, and pea-vine hay.

Lot 4, cotton seed, cotton-seed hulls, and pea-vine hay.

Lot 5, cotton seed and pea-vine hay.

The rations were the same in kind throughout the trial, but the amount fed was regulated by the individual appetites. At the close of the experiment the animals were immediately shipped to the Armour Packing Company at Kansas City, Missouri, where they were slaughtered under the supervision of the station. The company determined the dressed weight, the weight of tallow and of rendered tallow, and

the melting point of the tallow, and also made careful examinations of the quality of the beef and tallow from each animal. These data are reported, together with statements of the amount and cost of the food consumed by each animal, the total gain in live weight, the cost of food per pound of live weight gained, and analyses of each of the feeding stuffs. Differences due to individuality were very noticeable in animals of the same lot, so that exact conclusions as to the relative effects of the different rations are impossible. The cost of food per pound of gain, not taking the value of the manure into account, was lowest in the case of lot 1 (cotton-seed meal and hulls), lot 4 (cotton seed, cotton-seed hulls, and pea-vine hay) ranking second in this respect. The cost was highest with lot 2 (corn and pea-vine hay), being more than two and a half times as large as with lot 1.

There was no difference in appearance due to the food between the lot fed cotton-seed meal and cotton hulls and the lot fed corn and pea-vine hay. * * * Summing up the data obtained from the feeding and slaughtering of the eleven steers, the conclusion is that there were not detected through the usual manner of manipulating beef, any detrimental effects from cotton-seed products fed to the animals.

EXPERIMENTS WITH FERTILIZERS FOR COTTON, B. M. BAKER (pp. 147–149).—The yields are tabulated for cotton grown with the use of cotton-seed meal, dried blood, leather scrap, sulphate of ammonia, and nitrate of soda; with a mixture of six parts of cotton-seed meal and two parts of acid phosphate, and the same with one part of kainit; and with cotton-seed meal, acid phosphate, and kainit, used singly, two by two, and all three together. No conclusions are given, except that of the two mixtures the one containing kainit generally gave the largest yields.

Varieties of cotton (p. 147).—Tabulated yields for 21 varieties of cotton.

Kansas Station, Bulletin No. 22, August, 1891 (pp. 25).

SMUT OF OATS IN 1891, W. A. KELLERMAN, PH. D. (pp. 73–81).—Previous accounts of statistics and experiments on oat smut (*Ustilago avenæ*) may be found in Bulletins Nos. 8 and 15 and in the Annual Report of the station for 1889 (see Experiment Station Record, vol. I, p. 216, and vol. II, pp. 342 and 638). Tabulated data are given for counts of the amount of oat smut in 1891 in fields on seven different farms near Manhattan, Kansas. Of the 28,807 heads counted, 1,660 were smutted, showing the average percentage of smut to be 5.76. The amount of smut in different fields varied from 3.2 to 7.92 per cent. The results of experiments with fungicides are also tabulated. Potassium sulphide was used in solutions varying from $\frac{1}{8}$ to 20 per cent during from 5 minutes to 24 hours. In one case calcium sulphide was used, and in several instances different amounts of sulphur. The potassium sulphide proved an effective fungicide this year as in 1890. "It may be used in a weak solution (say 1 pound to 20 gallons of water), in which the seed

should be soaked 24 hours; or it may be used in a solution twice as strong, allowing the seed to remain in it only 10 or 12 hours.

In previous experiments, reported in the Annual Report of the station for 1889 and in Bulletins Nos. 15 and 21 (see Experiment Station Record, vol. II, pp. 342 and 640, and vol. III, p. 225), an extra increase of yield was observed on the plats treated with hot water or potassium sulphide. A further test of this matter in 1891 is reported in detail in tables and illustrated in diagrams.

The following is a summary of the results:

Treatments (each on 6 plats).	Yield of grain per acre.	Increase of yield.*	Extra increase of yield.
	Bushels.	*Per cent.*	*Bushels.*
Untreated	53.10	....	....
Hot water, 143½° F., 5 minutes	62 10	16.76	5.75
Hot water, 134½° F., 10 minutes	62 10	16.76	5.75
Hot water, 134½° F., 3¼ minutes (previously soaked 3 hours)	60.75	14.40	4.40
Hot water, 132½° F., 15 minutes	60 30	13.56	3 95
Hot water, 132½° F., 10 minutes (not cooled)	64.35	21 18	8 00
Potassium sulphide, ½ per cent solution, 24 hours	58.50	10.17	2.15
Results expected from simply replacing smutted heads with sound ones	56 35	6.11	....

* The seed being damp and swollen a smaller quantity per acre was drilled.

Tests of fungicides to prevent loose smut of wheat, W. A. Kellerman, Ph. D. (pp. 81–90).—A summary of available information regarding loose smut of wheat (*Ustilago tritici*) was given in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 342), and accounts of experiments with fungicides for stinking smut of wheat (*Tilletia fœtens* and *T. tritici*) may be found in Bulletins Nos. 12 and 21 of the station (see Experiment Station Record, vol. II, p. 220, and vol. III, p. 225). The amount of loose smut found on 25 varieties of wheat grown at the station in 1891, as stated in a table, ranged from 0 to 16 per cent. Tabulated data are given for experiments with 54 different methods of treatment tested on as many plats, alternate plats remaining untreated. The fungicides used were Bordeaux mixture, eau celeste, copper sulphate, potassium bichromate, copper nitrate, verdigris, copper chloride, mercuric chloride, Ward's Seed Manure, and hot water. Very little smut appeared on the untreated plats, and the data reported do not conclusively favor any of the treatments.

Spraying to prevent wheat rust, W. A. Kellerman, Ph. D. (pp. 90–93).—Notes and tabulated data for an experiment in which flowers of sulphur, potassium sulphide, chloride of iron, and Bordeaux mixture were applied singly at intervals usually of 8 days from April 21 to July 2, 1891, inclusive, on Fife and Blue Stem spring wheat, Chevalier, Four-Rowed, Melon, Saal, Prize Prolific, and Algerian barley, and Black Winter oats, with a view to preventing red and black rust (*Puccinia* sp.). The fungicides apparently had little if any effect. However, attention is called to the fact that frequent rains may have materially interfered with the success of the experiment.

Kansas Station, Bulletin No. 23, August, 1891 (pp. 15).

EXPERIMENTS WITH SORGHUM SMUTS, W. A. KELLERMAN, PH. D. (pp. 95–101, plates 3).—Two species of smut have been found on sorghum in Kansas, *Ustilago sorghi*, which attacks the individual grains, and *Ustilago reiliana*, which converts the whole head into a large black mass. *Ustilago sorghi* (Passerini in Thüm. Herb. myc. oec. n., 63) has been reported in this country from Washington, D. C.; Madison, Wisconsin; New York; Lincoln, Nebraska; and Manhattan and Sterling, Kansas, on plants grown from foreign seed.

Ustilago reiliana (Kühn in Rabenhorst, Fungi europæi exsiccati, cent., 20, No. 1988) was found in 1890 at Manhattan and Sterling, Kansas and in New Jersey, on plants from foreign seed. In a preliminary test in a greenhouse at the station with the seed of Red Liberian, Rangoon, Early Amber, White Kaffir Corn, and a variety from Calcutta the plants in nine of the fifteen pots in which infected seed was planted, produced smutted heads (*Ustilago sorghi* in seven cases and *U. reiliana* in two cases). A field experiment with infected seed, and with potassium sulphide, chloride of iron, and hot water as fungicides to prevent the smut, is also reported in notes and tables. The untreated plats gave from 1 to 3.3 per cent of smutted heads and there was no smut where either potassium sulphide or hot water was used. "The artificial infection of the seed does not seem to be successful."

EXPERIMENTS WITH CORN SMUT, W. A. KELLERMAN, PH. D. (pp. 101–105).—Attempts in the greenhouse and in the field to infect corn by adding a quantity of the spores of corn smut (*Ustilago zeæ-mays*) to the seed were unsuccessful. Spraying corn plants with Bordeaux mixture, chloride of iron, or potassium sulphide did not prevent the development of corn smut. Details are given in notes and tables.

Massachusetts State Station, Bulletin No. 41, September, 1891 (pp. 16).

METEOROLOGY (p. 1).—Meteorological summary for July and August, 1891.

COMMERCIAL FERTILIZERS (pp. 2, 3).—Tabulated analyses of 23 samples of commercial fertilizers, including tankage and bone.

FEEDING EXPERIMENTS WITH MILCH COWS, C. A. GOESSMANN, PH. D. (pp. 4–16).—These experiments were designed to compare the effects of like amounts of cotton-seed meal, old-process linseed meal, and gluten meal on the cost of food and the quantity and quality of milk produced. These materials were each fed with 3 pounds of corn meal and 3 pounds of wheat bran, and coarse foods consisting of rowen hay, corn stover or hay, and a mixed silage made of equal parts by weight of green fodder corn and green soja beans. The rations fed each

period in addition to the 3 pounds of corn meal and 3 pounds of wheat bran, which were fed at all times, were as follows:

Period 1, 3 pounds cotton-seed meal and rowen hay *ad libitum*.
Period 2, 3 pounds gluten meal and rowen hay *ad libitum*.
Period 3, 3 pounds linseed meal and rowen hay *ad libitum*.
Period 4, 3 pounds cotton-seed meal, 5 pounds rowen hay, and mixed silage *ad libitum*.
Period 5, 3 pounds gluten meal, 5 pounds rowen hay, and mixed silage *ad libitum*.
Period 6, 3 pounds gluten meal and corn stover *ad libitum*.
Period 7, 3 pounds cotton-seed meal and corn stover *ad libitum*.
Period 8, 3 pounds cotton-seed meal and rowen hay *ad libitum*.
Period 9, 3 pounds gluten meal and rowen hay *ad libitum*.

In all nine grade cows in different stages of the milking period were used in the experiment, but at no time were there more than six cows included in the test, some of the cows being replaced by others when their milk yield became too small. The experiment lasted from November, 1890, to June, 1891. During this time the gluten meal ranged in price from $24.50 to $28, the linseed meal from $26 to $27, and the cotton-seed meal from $26 to $28 per ton. The tabulated record for each cow includes the history of the cows; the analyses of the corn meal, wheat bran, cotton-seed meal, old-process linseed meal, gluten meal, rowen hay, corn and soja bean silage, and corn stover, with reference to both food and fertilizing ingredients; the amount of each food consumed; the nutritive ratio of each ration; yield and composition of the milk; and the live weight gained during the feeding periods.

[With regard to the yield of milk,] almost without an exception changes in the coarse fodder affected the results more seriously than changes in the grain. * * * Mixed silage with rowen in place of corn stover in some instances raised the daily yield of milk more than 3 quarts; allowing 3 cents per quart of milk, makes the former (mixed silage and rowen) the cheaper coarse fodder article of the two. These results are noticeable without reference to the particular combination of grain used in either case.

The conclusions of the author are that (1) at the prevailing market prices there was no marked difference in the effects of the cotton-seed meal, gluten meal, and old-process linseed meal on the gross cost of the rations. Making the usual allowances for the value of the manure, the "3 pounds of cotton-seed meal are 0.94 cent cheaper than 3 pounds of gluten meal, and 0.22 cent cheaper than 3 pounds of old-process linseed meal." (2) With regard to the milk yield, where the coarse fodder consisted of rowen hay alone "cotton-seed meal leads in five out of six cases," and where silage and hay or corn stover were fed "the gluten meal competes well with cotton-seed meal." (3) "The density of the milk in case of the same cow varied but little during the experiment; the notable changes were apparently in a controlling degree due to the particular condition and individuality of the cow used in the trial."

The superior feeding effect of green soja beans as a coarse fodder constituent in the diet of milch cows, has been shown in our summer feeding experiments of 1890, reported in the Annual Report of the station for 1890, pp. 39–54 [see Experiment Station Record,

vol. III, p. 153]. The influence which an addition of an equal weight of nearly mature soja beans exerts on the composition of corn silage will be seen from a comparison of the following analyses:

Composition of dry matter of corn silage and corn and soja bean silage.

	Corn silage.	Corn and soja bean silage.
	Per cent.	*Per cent.*
Crude ash	6.73	11.04
Crude cellulose	26.90	27.84
Crude fat	3 27	5.35
Crude protein	8.97	14.27
Nitrogen-free extract	54.13	40.50
Total	100.00	100.00

The clear corn silage was obtained from the same lot of fodder corn which served for the production of the mixed silage. The silos were in both cases filled in the same way, and as far as practicable at the same time; they were of corresponding size and contained fairly even quantities of vegetable matter. Both were opened for general use at about the same time—4 months after filling. The samples which served for the analyses represent in each case the average of the silage obtained by cutting in a vertical direction through the contents of each silo. The composition of the dry vegetable matter of the mixed silage compares well with that of a medium quality of red clover hay.

Massachusetts Hatch Station, Bulletin No. 15, October, 1891 (pp. 16).

EXPERIMENTS IN GREENHOUSE HEATING, S. T. MAYNARD, B. S. (pp. 3–7).—Reference is made to previous experiments in which steam and hot-water systems for heating greenhouses were compared, as reported in Bulletins Nos. 4, 6, and 8 of the station (see Experiment Station Record, vol. I, pp. 82 and 225, and vol. II, p. 104). This article contains an account of experiments in the two greenhouses previously used, to test overbench as compared with underbench heating. The hot-water system was used in both houses, and each house was divided into north and south sections, "in the former of which were grown coleus, roses, and other plants requiring a high temperature, while in the latter were grown lettuce, carnations, and other plants requiring a lower temperature." The results of an experiment begun December 1, 1890, and ended April 12, 1891, are recorded in three tables. One of these contains the daily record of the temperature of the house and the amount of coal consumed for each day of January; the second gives the average temperatures and the amounts of coal consumed for each month; the third shows the distribution of heat through the houses during different weeks. It was found that "while the average temperature of the water as it came from the boiler in the west house with pipes over the benches, was 4.81° higher than that from the east boiler, where the pipes ran under the benches, the house temperature was only 0.25° higher." One hundred and seventy-nine pounds more coal was consumed in the west house than in the east one. The circulation of the hot water in

the pipes over the benches was more rapid and regular than where the pipes ran under the benches. As regards the growth of plants, the results with carnations, lettuce, cuttings, and flower seed were in favor of the underbench piping. The blossoms of nearly mature or budding plants came out more quickly where the pipes were over the benches. The heat was more equally distributed through the houses where the pipes were under the benches.

SPECIAL FERTILIZERS FOR PLANTS UNDER GLASS, S. T. MAYNARD, B. S. (pp. 7, 8).—These experiments were in continuation of those reported in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 235), and were carried on in the greenhouses above mentioned. During 31 weeks the following numbers of carnation blossoms were obtained with the use of different fertilizers: Nitrate of potash 1,261, nitrate of soda 1,353, sulphate of ammonia 1,345, sulphate of potash 1,475, nitrate of potash 1,601, dissolved boneblack 1,069. The results of 5 experiments made in this line have varied; 3 favored boneblack, 1 sulphate of ammonia, and 1 nitrate of potash. Sulphate of potash stood second in each one of them.

TESTS OF VARIETIES OF SMALL FRUITS, S. T. MAYNARD, B. S. (pp 8, 16).—Tabulated data are given for 93 varieties of strawberries, 16 of blackberries, 19 of red raspberries, and 13 of blackcap raspberries, with brief descriptive notes on a few of the varieties. Injuries to strawberries by the black paria (*Paria aterrima*) and by rust (*Ramularia fragariæ*) are reported. Some varieties of blackcap raspberries suffered seriously from anthracnose (*Macrosporium punctiform*). The following varieties are especially recommended: *Strawberries.*—Beder Wood, Bubach No. 5, Haverland, Belmont, Warfield, Eureka, Middlefield, Sharpless, and Crescent. *Blackberries.*—Of the varieties fully tested, Agawam, Taylor Prolific, and Snyder; of the newer varieties, Erie, Minnewaski, Fred, and Stone Hardy. *Red raspberries.*—Marlborough, Cuthbert, and Hansel.

Michigan Station, Bulletin No. 75, July, 1891 (pp. 11).

FERTILIZER ANALYSES, R. C. KEDZIE, M. A.—The text of the State fertilizer law and a discussion of the object of inspection of fertilizers are given, together with tabulated analyses of 40 brands of fertilizers, including bone and "azotine," collected in the State during 1891.

Michigan Station, Bulletin No. 76, October, 1891 (pp. 16).

KEROSENE EMULSION AND NOTES ON INSECTS, A. J. COOK, M. S., AND G. C. DAVIS, M. S. (figs. 8).—Reference is made to previous statements regarding kerosene emulsion in Bulletins Nos. 58 and 73 of the station (see Experiment Station Record, vol. II, pp. 63 and 730). Formulas are given for kerosene emulsion with soft and hard soap, kerosene

and milk emulsion, and kerosene and pyrethrum emulsion. Experiments by the author and others are cited to show that kerosene emulsion is an effective insecticide for lice on cattle, horses, and hogs, and for ticks on sheep; and for the rose chafer (*Macrodactylus subspinosus*), the hollyhock bug (*Orthotylus delicatus*), the yellow-lined currant bug (*Pœcilocapsus lineatus*), plant lice, pear and cherry slug (*Eriocampa cerasi*), and pea weevil (*Bruchus pisi*). The pyrethrum kerosene emulsion was also successfully used for the rose chafer, the hollyhock bug, and the yellow-lined currant bug, and the author believes that this insecticide will be effective for plant lice. Both emulsions have been found destructive to the eggs and larvæ of the squash bug (*Anasa tristis*), but failed to kill the mature bugs.

A large number of experiments on different kinds of plants have indicated that one part of kerosene to fifteen of the hard-soap solution is safe on all plants. Where soft soap is used the amount of soap will in many cases need to be reduced. When pyrethrum is used with kerosene, one part of kerosene to twelve of the soap solution is recommended. Hot water (130° to 150° F.) was successfully applied with a common nozzle to plants attacked by the rose chafer. The experience of the author leads him to believe that this remedy can be used only on warm days. The bulletin also contains descriptive notes on the hollyhock bug, yellow-lined currant worm, oak caterpillar (*Edema albifrons*), white pine sawfly (*Lophyrus abbottii*), and a white pine sawfly parasite (*Perilampus hyalinus*).

New Hampshire Station, Second Annual Report, 1889 (pp. 72).

REPORT OF DIRECTOR, G. H. WHITCHER, B. S. (pp. 7–62, plate 1).—This consists of a brief survey of the work of the year; abstracts of Bulletins Nos. 5, 6, 7, and 8 of the station (see Experiment Station Record, vol. I, pp. 127, 130, 255); and a plan of the station grounds.

GROWTH OF TIMOTHY GRASS, F. W. MORSE, B. S. (pp. 63–69).—This is a study of the changes in the nutritive constituents of timothy grass during its growth, with a view to finding the best time for cutting. Analyses are given of timothy cut every 5 days from June 4 to July 31, together with the yield of green grass, and the calculated amounts of digestible food ingredients for each cutting. The following are the author's conclusions:

Timothy grass grows very rapidly until the blossom appears. Its fastest growth is between the appearance of the head and beginning of bloom.

The amount of grass per acre increases until the time of blossoming; it then decreases. The decrease is due to loss of water.

Dry substance steadily increases until the plant forms seed.

The young grass is richest in fat and protein. The mature grass is richest in carbohydrates (or fiber and nitrogen-free extract).

Timothy yields the largest amount of digestible protein when cut at the beginning of bloom.

The total amount of digestible matter is largest when the grass has passed out of blossom or gone to seed.

MISCELLANEOUS ANALYSES (pp. 69–71).—Analyses are given of mixed feed and hay heated in the mow with reference to food ingredients, and of Bellamy bone phosphate, tobacco and sulphur, muck, milk, butter, Insect Exterminator, and paint.

FINANCIAL STATEMENT (p. 72).—Report of the receipts and expenditures of the station for the fiscal year ending June 30, 1889.

New Jersey Stations, Annual Report, 1889 (pp. 355).

REPORT OF TREASURER OF STATE STATION, J. NEILSON (p. 11).—This is for the calendar year 1889.

REPORT OF DIRECTOR, M. E. GATES, PH. D. (pp. 13–22).—This is an outline statement of the work of the stations during 1889. Special reference is made to the loss sustained by the stations in the death of the former director, George H. Cook, LL. D., which occurred September 22, 1889.

FERTILIZERS, E. B. VOORHEES, M. A. (pp. 23–101).—*Fertilizer statistics* (pp. 24–29).—This includes statistics as to the amount and value of the fertilizers sold in the State during 1889, and a comparison of prices, amount, and quality with those of each year from 1882 to 1888.

A report from forty out of the fifty-six firms in the State dealing in fertilizers, including those having the largest sales, indicated that during 1889 they sold within the State 32,246 tons of fertilizers, valued at $1,106,223.

The complete manures represent 74 per cent of the total number of tons sold and 77 per cent of the total value of all sales. * * * [A comparison of the prices in 1889 with those in previous years] shows that the average prices for these complete fertilizers fell steadily from 1882 to 1887, when it was 15 per cent lower, and that the average price of this year [1889] is about 4 per cent higher than that of 1887 and 1888. * * *

[It is further shown that] the decline in the prices of complete fertilizers from 1882–'87 was not accompanied by a corresponding decrease in the absolute amounts of plant food delivered to consumers, and the increase in price for 1889 was not accompanied by any increase in the amount of plant food delivered to consumers.

Commercial relations of fertilizers (pp. 29–101).—Under this heading are given a comparison of the wholesale and retail prices of fertilizing ingredients from 1885 to 1889; a monthly review of the prices of crude fertilizing ingredients during the year; the average retail prices of nitrogen, phosphoric acid, and potash from different sources since 1885; a popular discussion of the sources of supply of nitrogen, phosphoric acid, and potash; general suggestions as to how to buy and how to use commercial fertilizers; abstracts from the State fertilizer law; a description of the station's method of collecting samples of the fertilizers sold within the State; the schedule of trade values of fertilizing ingredients for 1887, 1888, and 1889; and analyses of 239 samples of commercial fertilizers, including bone, fish scrap, horse meat, and kainit, collected in the State

during 1889, together with samples of "tailings from concentrating iron ore," flue dust from iron works, and tomato pomace.

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES, E. B. VOORHEES, M. A. (pp. 102–127).—A reprint of Bulletin No. 63 of the station (see Experiment Station Record, vol. I, p. 261).

FIELD EXPERIMENTS WITH FERTILIZERS, E. B. VOORHEES, M. A. (pp. 127–153).—*Fertilizers on clover* (pp. 128–132).—In 1882 a series of experiments was commenced under the direction of the station on the farm of Mr. A. P. Arnold, to determine (1) "the effect of barnyard manure upon a rotation of crops compared with the effects of the leading elements of plant food used separately and in combinations; (2) the financial results which follow the use of commercial fertilizers." The rotation consisted of corn, sweet potatoes, clover and millet, and clover. The soil is described as "a very sandy loam, easily tilled, responsive to fertilizers, and especially suitable for the cultivation of sweet potatoes, berries, and small fruits." The experiment included 11 tenth-acre plats, and has been continued each year up to 1889, when clover was the crop raised. Each plat received the same treatment from year to year except in 1889, when no fertilizers were applied on any of the plats. On seven of the plats nitrate of soda, superphosphate, and muriate of potash had been used singly, two by two, or all three combined; plaster and barnyard manure had each been applied on one plat; and two plats had received no fertilizer during the 8 years. The yield of clover in 1889, the value of each previous year's crop, the total value of the crops for 8 years, and the cost of fertilizers during this time are tabulated for each of the eleven plats. The financial results for the 8 years show that where nitrate of soda or superphosphate, alone or combined, or plaster was used the total value of the crops, after deducting the cost of manures, was less by from $11.96 to $24.04 per plat than where no fertilizer was used. In the other cases there was a gain in net value over the unfertilized plats varying from $63.52 to $157.33 per plat, the largest gain occurring where barnyard manure had been used. A considerably larger amount of fertilizing ingredients was supplied by the barnyard manure than by the complete fertilizer composed of nitrate of soda, muriate of potash, and superphosphate. "While profit has accrued from the continued use of barnyard manure in large quantities, the yields have not only not been in proportion to those quantities, but the proportions of the elements removed in the crops have not been in the proportions in which they have been supplied in the manure."

Fertilizers on peach trees (pp. 133–137).—This experiment has been in progress on the farm of Mr. S. C. Dayton since 1881, the fertilizers used being the same as in the preceding series of experiments. The results are tabulated for 1889, and compared with those in 1887 and 1888. "The best yields secured in 1889 were from those plats upon which potash had been applied, the highest yield, 166.7 baskets, being where a mixture of potash and nitrate of soda was used. This result is, as Mr.

Dayton says, contrary to all precedent, superphosphate having been the ruling element on all crops upon his farm in previous years."

Canada ashes, domestic ashes, dissolved South Carolina rock, and Orchilla guano (pp. 137–140).—This is a comparison of these materials on the farm of Mr. A. P. Arnold for 5 years, the rotation of crops being the same as that given above. One hundred bushels of the ashes, 1,000 pounds of the rock, or 1,000 pounds of the Orchilla guano per acre were each used on one plat. The results are tabulated for each year. "The best yields were secured from the large dressings of Canada ashes."

Fertilizers on oats (pp. 140–142).—On two different farms experiments were made in which 150 pounds of muriate of potash and 300 pounds of dissolved boneblack per acre were used alone or combined on 3 tenth acre plats, and 2 plats remained unfertilized. The results are tabulated. "Owing to the unfavorable conditions existing this year very little has been gained by these experiments, and a further study of this crop will be made."

Fertilizers on potatoes and silage corn (pp. 142–146).—Field experiments to test "(1) the effect of potash when used alone; (2) the relative effect of equal weights of actual potash derived from muriate of potash and from kainit; and (3) the effect of common salt," were made on the college farm and at seven other farms in the State, four experiments being with corn and four with potatoes. The plats at the college farm were one twentieth-acre each; those in the other experiments one tenth-acre each. In the corn experiments muriate of potash 150 and 200 pounds, kainit 600 and 800 pounds, and common salt 200 and 250 pounds per acre were each used on one plat, three plats remaining unfertilized. In the potato experiments the treatment of the plats was very similar. The experiments were inconclusive. The season was very unfavorable and the potatoes suffered from the rot.

Phosphatic fertilizers on wheat (pp. 147–151).—In response to a request from the Salem County board of agriculture, experiments were planned to test the relative value of like amounts of phosphoric acid in the form of boneblack or South Carolina rock, and wheat was selected as the crop. The experiments were carried out on four farms in Salem County and on the college farm. "The farms in Salem County are all underlaid by marl beds." From 6 to 9 tenth-acre plats were used in each experiment. A mixture furnishing 15 pounds of nitrogen and 20 pounds of potash per acre was applied on all the plats. In addition to this, 330 pounds of boneblack (containing 19.62 per cent available phosphoric acid) or 440 pounds of dissolved South Carolina rock (containing 12.49 per cent available phosphoric acid) were applied on all the plats except two or three, which received no phosphate. The yields and financial results are tabulated for each experiment. "The value of crops on those plats fertilized with phosphoric acid from either boneblack or South Carolina rock were practically identical. The widest

difference in value of crops, $2.48 per acre, is shown on the college farm."

ALFALFA, E. B. VOORHEES, M. A. (pp. 153–160).—This is a report for 1889 of the yields of alfalfa sown broadcast and in drills, being a continuation of an experiment commenced in 1887 (see Experiment Station Bulletin No. 2, part I, p. 126). A piece of land 150 by 30 feet was seeded to alfalfa in April, 1887, the seed being sown broadcast on one half at the rate of 30 pounds of seed per acre, and in drills 14 inches apart on the other half at the rate of 15 pounds per acre. The fertilizers were the same for both halves. In 1889 four cuttings of alfalfa were made—May 29, July 5, August 12, and in September. The total yield of green fodder from these four cuttings is given at 22½ tons per acre for the drilled plat, and 24¾ tons for the broadcast plat. The yields are also tabulated for 1887 and 1888, together with the calculated amounts of hay and of nutritive ingredients and the money value of the same, and these averages are compared with the averages for clover and timothy hay.

The crop has increased in yield each year notwithstanding a disease which materially reduced the yields of the third cuts in 1888 and 1889. * * *

The prospect for future crops is also quite as good as at any time since seeding the plats.

Though the broadcast plat produced much larger yields in both 1888 and 1889 than the drilled plat, final comparisons on this point can be properly drawn only when the plats cease to produce profitable yields. * * *

The chemical analysis of samples from the three cuts in 1887 and the four cuts in 1888 showed that there were no decided variations in the composition of the alfalfa from the different cuts or in the different years.

[At the time of the third cutting (August 12) the leaves of] many of the plants were quite yellow (supposed to be due to *Cercospora helvola*) and distinctly spotted with the fungous growth *Phacidium medicaginis*. * * * It is estimated that nearly one half of the plants were attacked at the time of taking the third cut. [Analyses, which are tabulated, of samples of the healthy and the diseased plants with reference to both food and fertilizing ingredients], show wide variations in the different classes of food compounds when brought to the water-free basis, the healthy plant having 10 per cent more fat, 12 per cent more protein, and 18 per cent more fiber than the diseased, while the diseased plant has 11 per cent more carbohydrates and ash than the healthy plant. This difference is more distinctly shown by calculating the nutritive ratio of the digestible compounds. This is found to be for the healthy plant 1:3.28, and for the diseased plant 1:3.83.

The higher percentage of ash in the diseased plant seems to be largely due to differences in percentage of potash [2.58 per cent in the healthy and 3.12 per cent in the diseased plants, water-free].

Alfalfa as a collector of plant food (pp. 159, 160).—The calculated amounts per acre are given of nitrogen, phosphoric acid, and potash contained in the crops of 1887, 1888, and 1889, and the commercial value of the same. It is estimated that these three crops contained 912 pounds of nitrogen, 161 pounds of phosphoric acid, and 934 pounds of potash, valued at $213.44. "There had been applied since the seeding of the crop less than 200 pounds of actual potash. Since alfalfa is a

deep-rooting plant, it is quite likely that large quantities of this element had been secured from the deeper layers of subsoil."

FODDERS AND FEEDS, E. B. VOORHEES, M. A. (pp. 161–177).—A brief discussion is given of the food ingredients of feeding stuffs and of German feeding standards for animals under different conditions. Analyses (with reference to both food and fertilizing ingredients) made at the station during 1889 are recorded in tables for the following feeding stuffs: Horse sorrel, gluten meal, fodder corn, alfalfa, and pasture grass (seven different kinds, as timothy third year after rye, timothy first and second years after wheat, first year's timothy and clover, second year's timothy and alsike clover, mixed seventeenth year, and Raritan River meadow), and of timothy hay harvested in clear weather and that which lay through a continuous rain for 17 days (1) in the swath and (2) in cocks. There is also a compilation of analyses (food and fertilizing ingredients) made at the station, including brewers' grain, corn meal, cotton-seed meal, gluten meal, old and new-process linseed meal, malt sprouts, ground oats, wheat bran, wheat middlings, wheat chaff, clover hay, orchard grass, pasture grass, rye grass, timothy hay, German millet, alfalfa, fodder corn, cornstalks (stover), oat straw, and wheat straw; and a comparison between the food ingredients in 60 pounds of pasture grass and in seven rations "assumed as used in general practice."

EXPERIMENTS WITH DIFFERENT BREEDS OF DAIRY COWS, E. B. VOORHEES, M. A. (pp. 178–186).—A reprint of the accounts of this experiment given in Bulletins Nos. 57 and 61 of the station (see Experiment Station Record, vol. I, pp. 258 and 260).

SORGHUM AND SUGAR MAKING (pp. 187–189).—A statement of the experiments in the field and in the sugarhouse at Rio Grande, New Jersey, during 1889. A severe storm in September so injured the crop that the yield of sugar was materially reduced.

REPORT OF CHEMICAL GEOLOGIST, H. B. PATTON, PH. D. (pp. 191–196).—The first year of the work of the station in the line of soil investigations has been spent in reviewing the work already done in this and other countries, in making a general study of the soils of the State, in collecting typical samples of soil, and in determining the lines of investigation to be immediately undertaken. It has been decided to study the red soils of New Jersey with reference to the relations between the color of the soil and its physical properties and fertility. Questions relating to the flocculation of soils will also be investigated. The method adopted for the preparation of soil samples for chemical and physical analysis is described.

REPORT OF BIOLOGIST, J. NELSON, PH. D. (pp. 197–220).—The biologist of the station is engaged for the most part in investigations relating to the oyster industry. The statistics of this industry in New Jersey were given in the Annual Report of the station for 1888 (see

Experiment Station Bulletin No. 2, part I, p. 136). The present report contains general statements regarding the condition and needs of this industry in the United States, a historical résumé of ostreacultural experiments and methods, and a brief account of experiments by the author in the culture of oysters in a *claire* at Key Port, New Jersey, and in the station laboratory. Most of the work of the year was preparatory and actual experimenting was not begun until late in the season. The laboratory experiment was materially interfered with by the impurity of the water used and the improper construction of the tanks. The author records a discovery that spermatozoa may survive the death of the oyster at least 5 days.

REPORT OF BOTANIST, B. D. HALSTED, D. SC. (pp. 221–239).—This is for the first 10 months during which the station has had the services of a botanist. A considerable portion of this time was necessarily occupied in preparatory work. The report includes notes on weeds along the same lines as those treated in Bulletin No. 52 of the station (see Experiment Station Record, vol. I, p. 130); explanations regarding the pollen of plants, with a brief account of observations by a number of persons in New Jersey, with reference to the relation between wet weather at the time of the blooming and the setting and maturing of fruit. An outline of the plan of these experiments was given in Special Bulletin C of the station (see Experiment Station Record, vol. I, p. 134). The season of 1889 was very wet and thus unfavorable for such experiments. In the case of apples it was observed that no fruit was set when the flowers were not permitted to get dry. Keeping strawberry vines wet during the time when the fruit is setting is probably undesirable.

Some experiments were made in clipping the lower half of currant clusters. This practice increased the number, size, and weight of the berries as compared with those on untreated bushes. There are also brief notes on potato rot (*Phytophthora infestans*), grape rot, cranberry gall fungus (*Synchytrium vaccinii*), cranberry scald, cucumber mildew (*Peronospora cubensis*), sweet potato rots (*Rhizopus nigricans*, *Ceratocystis fimbriata*) leaf blight on lilac (*Phyllosticta halstedii*), and fungicides. Observations on the two diseases of the cranberry above referred to were reported in Bulletin No. 64 of the station (see Experiment Station Record, vol. I, p. 263). The cucumber mildew was first observed on cucumbers growing under glass, and was afterwards found on pumpkins, squashes, and field cucumbers in various parts of the State.

REPORT OF ENTOMOLOGIST, J. B. SMITH (pp. 241–313, figs. 22).—The author assumed the duties of entomologist to the station April 1, 1889. Considerable preliminary work was necessary in securing apparatus and making collections of insects. General information regarding this department was given in Bulletin No. 55 of the station (see Experiment Station Record, vol. I, p. 134). The report contains an account of the horn fly (*Hæmatobia serrata*), taken from Bulletin No. 62 of

the station (see Experiment Station Record, vol. I, p. 260); compiled and original notes on the periodical cicada (*Cicada septendecim*), imported elm leaf beetle (*Galeruca xanthomelæna*), imported elm borer (*Zeuzera pyrina*), clover leaf beetle (*Phytonomus punctatus*), asparagus beetle (*Crioceris asparagi*), grape plume moth (*Oxyptilus periscelidactylus*), grape phymatodes (*Phymatodes amœnus*), codling moth (*Carpocapsa pomonella*), yellow-necked apple tree caterpillar (*Datana ministra*), plum curculio (*Conotrachelus nenuphar*), peach borer (*Sannina exitiosa*), white cabbage butterfly (*Pieris rapæ*), fall webworm (*Hyphantria cunea*), grapevine sawfly (*Selandria vitis*), and cutworms; statements regarding the preparation and use of Paris green, London purple, tobacco, and kerosene emulsion as insecticides; and descriptions of spraying machinery and the powder bellows.

Periodical cicada.—Brood No. 8, as recorded in Bulletin No. 8 of the Division of Entomology of this Department, appeared in New Jersey in 1889, but in such small numbers that they did little or no injury.

Imported elm leaf beetle.—Climax Insect Poison, a preparation of London purple, was successfully sprayed on trees infested with this insect. A mixture of London purple and kerosene emulsion, with and without rye flour, destroyed the eggs.

The larvæ as a rule were observed to come to the base of the trees for pupation. Those that pupated under the bark of the trees were "very generally attacked by a fungus that carried them off by the thousands." The pupæ can be readily destroyed by hot water sprinkled at the base of the tree. The author concludes from his observations that "a single annual brood is the rule in New Jersey, though there may be two in the southern part of the State."

Asparagus beetle.—Kerosene applied in a very fine spray killed a large proportion of the larvæ, but did not injure either the eggs or perfect beetles. London purple, applied at the rate of 1 ounce to 5 gallons of water, was entirely ineffectual. X. O. Dust, applied with a powder bellows, killed fully 90 per cent of all the larvæ. "The beetles were driven off but soon returned, while the eggs were not injured in any way."

White cabbage butterfly.—X. O. Dust, applied with a powder bellows, killed all the larvæ that were touched by it.

APPENDIX (pp. 315–336, plate 1).—This contains the acts of the State legislature relating to the station and to fertilizer inspection; directions for sampling fertilizers and feeding stuffs; the order of station work; a brief description of the station laboratory; and a catalogue of the bulletins of the station from May 17, 1880, to December 31, 1889, inclusive. A list of these bulletins to December 31, 1888, may also be found in Experiment Station Bulletin No. 2, part I, p. 142, and abstracts of the bulletins for 1889 are contained in Experiment Station Record, vol. I.

SECOND ANNUAL REPORT OF NEW JERSEY COLLEGE STATION (pp. 337–342).—This includes a brief account of the organization of the station, and a financial statement for the fiscal year ending June 30, 1889.

New Jersey Stations, Annual Report, 1890 (pp. 585).

REPORTS OF TREASURER (pp. 11 and 555).—An exhibit of the receipts and expenditures of the New Jersey State Station during 1890, and of the New Jersey College Station during the fiscal year ending June 30, 1890.

REPORT OF DIRECTOR (pp. 13–17).—A brief review of the work of the year and a list of the bulletins published during that time. M. E. Gates, LL. D., acting director of the station, resigned October 1, 1890, and J. Neilson was appointed in his stead.

FERTILIZERS (pp. 21–101).—This includes statistics on the amount and value of the fertilizers used in the State during 1890; a comparison of the year's trade with that of each preceding year since 1882; a comparison of the wholesale and retail prices of fertilizing ingredients for the past 3 years; a monthly review of the fluctuations in prices of crude fertilizing materials during the year, together with a summary of the same for each year since 1888; a popular discussion on the sources of nitrogen, phosphoric acid, and potash; a reprint from Bulletins Nos. 66 and 71 of the station (see Experiment Station Record, vol. II, pp. 164 and 280) of articles on the rational use of fertilizers, home-mixing, the composition of incomplete fertilizers, etc.; abstracts from the State fertilizer law; general information concerning the method of collecting samples of the fertilizers sold in the State; schedule of trade values for 1888, 1889, and 1890; and analyses of 314 samples of commercial fertilizers and fertilizing materials, including nitrate of soda, sulphate of ammonia, dried and ground fish, tankage, dried blood, cotton-seed meal, boneblack, bone ash, South Carolina rock, dissolved bone, ground bone, muriate of potash, kainit, sulphate of potash, sylvanit, cotton-hull ashes, ground tobacco stems, wood ashes, precipitated carbonate of lime, marl, wool waste, muck, and buckwheat hulls.

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES (pp. 102–120).—A reprint of Bulletin No. 79 of the station (see Experiment Station Record, vol. III, p. 30).

EXPERIMENTS WITH FERTILIZERS ON POTATOES (pp. 120–142).—A reprint from Bulletin No. 80 of the station (see Experiment Station Record, vol. III, p. 32).

FIELD EXPERIMENTS WITH FERTILIZERS ON WHEAT (pp. 142–149).—A reprint from Bulletin No. 80 of the station (see Experiment Station Record, vol. III, p. 35).

MISCELLANEOUS FIELD EXPERIMENTS (pp. 149–155).—*Nitrate of soda on timothy grass* (pp. 149, 150).—A trial with timothy on two plats 600 by 33 feet, on one of which nitrate of soda was applied at the rate of 100

pounds and at a cost of $2.25 per acre, the other receiving no nitrate, showed an increase of 590 pounds of dried hay per acre where the nitrate was used. With hay at $12 a ton "the profit from the use of nitrate is $1.29 per acre."

Fertilizers on sweet potatoes (pp. 150–152).—A preliminary experiment on 12 twentieth-acre plats on the farm of G. E. Farry. The fertilizers consisted of nitrate of soda, 160 and 320 pounds per acre, applied all at one time, May 20, or half then and the remainder June 20, both alone and in connection with superphosphate 320 pounds and muriate of potash 160 pounds per acre. One plat received the mixture of superphosphate and potash without nitrogen, another 20 tons of barnyard manure per acre, and two remained unmanured. The soil was very light and sandy. The table of yields shows the yield of merchantable potatoes to have been largest (120 bushels per acre) where barnyard manure was used, and next largest (85 to 90 bushels) where nitrate of soda was used with superphosphate and potash. The double amount (320 pounds) of nitrate of soda seemed to be without benefit to the crop, and where nitrate was used alone there was scarcely any increase of yield over that of the unmanured plats. "The yield of merchantable potatoes was increased over 60 per cent by the use of phosphoric acid and potash" without nitrogen. Allowing 75 cents per bushel for the sweet potatoes, "wherever nitrate was used alone, except on plat 2, there was a loss ranging from 25 cents to $8. There was a profit from the use of mineral elements alone [superphosphate and muriate of potash], and also in every case where the complete fertilizer was used, though not in any case as great as the profit from the barnyard manure when the cost of the manure is rated at $1.50 per ton."

Fertilizers upon peach trees (pp. 153–155).—A report is given for 1890 of the experiments carried on since 1887 on the farm of S. C. Dayton, the general plan of which was referred to in connection with the report for 1889 (see above, p. 293). A summary is given of the results in 1887, 1888, and 1889. The crop in 1890 was "a complete failure."

Another experiment was commenced in 1890 on the farm of S. S. Voorhees, trees being set on 3 fourth-acre plats and corn planted between the rows. The yield of corn is tabulated.

ALFALFA (pp. 156–160).—This is a continuation of the experiment commenced in 1887 (see above, p. 295), being a report of the yield of the drilled and the broadcasted plats in 1890 at four successive cuttings—May 22, June 24, July 30, and September 16. "The total yield of green fodder per acre was 22.7 tons from the drilled plat and 22.45 tons from the broadcasted plat."

The adaptability of this crop was further tested on another piece of land at the college farm and on three other farms in different parts of the State, the seed being broadcasted on plats one fourth to one half an acre in area. The seed and fertilizers were furnished by the station. In every case except at the college the growth of alfalfa after the first

cutting (June) "was so light that the experiment was considered a failure."

FODDERS AND FEEDS (pp. 161–167).—Analyses are tabulated showing the food and fertilizing ingredients of timothy hay, wheat straw, linseed meal, cotton-seed meal, malt sprouts, dried brewers' grains, Buffalo feed, and Chicago feed. There is also a compilation of analyses of various feeding stuffs.

EXPERIMENTS WITH DIFFERENT BREEDS OF DAIRY COWS (pp. 169–230).—A complete record is given of the data obtained in the test of breeds of cows from May, 1889, up to November 2, 1890, when it was prematurely terminated by fire. These data previously appeared in Bulletins Nos. 57, 61, 65, 68, and 77 of the station (see Experiment Station Record, vol. I, pp. 258 and 260, and vol. II, pp. 162, 241, and 499).

REPORT OF CHEMICAL GEOLOGIST, H. B. PATTON, PH. D. (pp. 231–248).—An account of investigations regarding the relation which flocculation in soils bears to their fertility. The samples of the soils investigated were taken according to the method recommended by Professor Hilgard. In every case both soil and subsoil were sampled, the latter, when possible, to a depth of at least 2 feet. The samples examined comprised "trap-rock soils," "Triassic red-shale soils," and a few from "Tertiary soils," and from soils formed by a mixture of the last two kinds. A few samples of clay were also taken for comparison with the clayey soils. Brief descriptive notes are given for each of the samples studied. A mechanical analysis of these soils was first made with reference to the relation, if any, between the size of the soil particles and fertility. The method of analysis used was the "beaker elutriation" method, devised by T. B. Osborne. The results are stated in detail in four tables. It was observed that the amount of organic matter and water in the soil seems to bear little relationship to the fertility. In the case of clayey soils there was a small difference in fertility in favor of the soil with relatively little clay. "It may be noted how very small the amount of clay is in even the heaviest soils," the average percentage of clay being only a little over nine. Sand was found in excess in the good soils, and the finer silt and dust in the poorer soils.

This is especially marked in the red shales and Tertiary soils, but not so much so in the trap-rock soils. The general scarcity of the coarser materials in the latter may account in part for the difference being so little between the good and poor soils. The exceptions to this in individual soils are quite inconsiderable when we consider that no account is taken here of probable differences in chemical composition.

It is well known that the trap-rock soils yield much poorer results on the average than the red-shale soils when under cultivation. During a dry season, however, the former have the advantage as they hold the water better. This experience agrees with the analyses in these two tables. On comparing the two it is seen that the better trap-rock soils contain over 60 per cent of silt and dust, while the better red-shale soils contain but little over 35 per cent of the same.

To study questions relating to the flocculation of soils, settling experiments were made with clays and with soils. "For this purpose beakers 5 cm. in diameter were employed. Five grams of soil or clay were taken, and for the purpose of removing the coarsest sand it was put through a sieve with 0.25 mm. holes. The beakers were then filled with water to a depth of 4 cm. After thorough stirring there was noted (1) the time required for the soil or clay to settle, (2) the condition of the sediment after a given lapse of time." The results are stated in tables. The clays, with the exception of one which more nearly resembled a natural soil in its mechanical composition, were very flocculent and settled rapidly. The sediment remained in a loose mass, which did not become compact and firm even after months' standing. As regards the soils, it was observed that in nearly all cases the subsoil was more flocculent than the surface soil, and that the trap soils were, as a rule, more flocculent than the others examined.

This tendency of the trap-rock soils to flocculate is undoubtedly a redeeming feature, as the good and poor soils belonging to the red shale and Tertiary areas do not appear to show this difference.

It would appear, therefore, that the very fine-grained soils naturally tend to flocculate. What breaks up the floccules at the surface is not so clear, whether the action of the frost or the mechanical action of the plow, or whether it is produced by the action of chemical agents. The effect of free ammonia [used experimentally by the author to break up floccules] would seem to indicate that the last is an effective cause, as free ammonia is generally present in soils. This suggests that the too free use of ammonia-forming fertilizers, as of manure, may very possibly have the effect of rendering the soil heavy by breaking up the floccules. On the other hand, the well-known action of lime on heavy soils is to make the soil light by assisting in the formation of floccules.

Report of Biologist, J. Nelson, Ph. D. (pp. 249–320).—A detailed account of laboratory experiments in ostreaculture by the author in the summer of 1890 at the station, and at Key Port and Oceanic, New Jersey. The report includes a description of the laboratory equipment and of the artificial sea water used; a list of questions in ostreaculture, which the author's experience shows to be proper subjects for investigation; an explanation of the methods of experimenting employed, and of the terms used in the tabulated record; tabulated data for observations on a considerable number of oysters; a calendar giving the dates and the temperature of the air in the laboratory for each set of experiments; a detailed record of experiments with the germ cells of the oyster; tables of the temperature of the water in or near oyster beds at Oceanic, Key Port, and Perth Amboy, New Jersey, for several months, as collated by volunteer observers; a discussion of the experiments, and observations under the following heads: Submarine climate, repetitive spawning, the effects of postmarinal age, viability of the spermatozoa and of the eggs, effect of solutions of different strengths, effect of temperature and saltness, dispersal of spawn, optimal saltness, acceleration of development, parasites, "mudding" of oysters, spawning oysters as food,

legal aspects of the oyster trade, technical problems, and miscellaneous. Tables are also given showing the viability of the spermatozoa in different solutions of sea water; effect of strength of solution and age of the oyster on the character of the development; influence of temperature, etc., on the rate of development of the oyster's eggs; factors affecting the viability of the eggs of the oyster; effects of age, etc., on the eggs. The following summary of the conclusions reached from a study of the summer's records is taken from the report:

Temperature and spawning.—(1) From the latter part of April until June, the temperature of the water upon the oyster beds at Perth Amboy, Key Port, and Oceanic rose steadily from about 50° F. until it reached 70°, June 1, in the Shrewsbury River, and about the middle of June in Raritan Bay.

(2) From this time on during the spawning season the temperature fluctuated between 70° and 80° F.

(3) Spawning began upon the respective beds very soon after the temperature reached the seventies.

(4) Seed obtained from the more northerly beds spawned first, and finished spawning relatively early.

(5) Seed from the Chesapeake region spawned later, and was the last to show spawn.

(6) The supposed evidence for the belief that the same oyster may repeat the spawning process more than once in a season was found insufficient.

(7) No oysters were found in which all the eggs were capable of developing. (Perhaps 70 per cent represents the most fruitful result obtained.)

(8) Seed which matures its sexual cells early produces more fruitful results in vigor and relative number of offspring than the later spawners of the same kind of seed.

(9) At Key Port after August 7 the spawning proper had ceased; only young Southern plants showed traces of spawn after this date.

Physiology of oysters.—(10) Oysters removed from the water and left dry at ordinary summer temperatures remain closed for about a week.

(11) When oysters begin to fail in the power of holding the shell closed they are not dead, for a stimulus will cause closure for a short time.

(12) Such oysters are partially spoiled, through fermentative action of bacteria, and are unfit for food.

(13) After this point of weakness is reached the death of the oyster is rapid. One day later it fails to respond to stimulation.

(14) Freshening oysters increases very rapidly the rate of weakening and decay of oysters. (The life period is reduced one half.)

(15) After an oyster is opened the death is rapid and in proportion to the length of time the oyster has been out of the water.

(16) If oysters be placed in limited supplies of sea water the postmarine life period is not lengthened, owing to the breeding of infusoria and bacteria in the water.

(17) Oysters open and shut their shells according to a rythmic or automatic law (while "breathing").

(18) Oysters differ greatly in the rapidity of this rythm of respiration (the object of which is to clear the external gill or mantle cavity of mud).

Parasites.—(19) Several species of infusoria are parasitic in the stomach, etc., of the oyster, but are not abundant enough to be taken account of in culinary interests.

(20) During the early portion of the spawning season there is abundantly present in a large proportion of oysters an infusorial parasite (average length $\frac{1}{500}$ inch), termed by us "cytohelminth" (wormlike cells). [Reference is made to an article by J. Ryder in *Science*, vol. 1, p. 567, containing a description of a parasite, named

by Ryder *Spirillum ostrearum*, and supposed to be the *Trypanosoma balbiani* of Certes. The author of this report believes that this is identical with the cytohelminth observed by him, and that until its life history is better known it can not be assigned to any particular genus and species.]

(21) These cytohelminths are bred in a structure which is or resembles the "crystalline rod," a flexible, gelatinous structure, shaped like a nematode worm, about an inch long, and situated in a loop of the intestine known as the "pyloric" portion.

Oyster economics.—(22) Oysters that are ready to spawn, if cooked soon after removal from the sea bed, are extra good and palatable food.

(23) Oysters in spawn deteriorate more rapidly than at any other season, at the same temperature.

(24) The warmth of summer acts upon oysters as upon other meats, especially fish, to produce rapid decay.

(25) Oysters in market should be under stringent inspection.

(26) Oystermen should not be required to freshen oysters; this should be done by the caterer just before cooking or serving.

(27) Oystermen should not be hampered by laws limiting the time or manner of taking or selling oysters.

The spermatozoa.—(28) Spermatozoa removed from a ripe male oyster and infused into sea water, begin a very active dancing motion either at once or after a "latent period" of a few minutes.

(29) The length of time an oyster has been out of water often determines whether a latent period is present. (Postmarine age in proportion to its length tends to produce this period.)

(30) The spermatozoa survive the death of the oyster for a period inversely proportional to the length of time which has elapsed between the taking of the oyster from its bed and the artificial opening of the same.

(31) The activity of the spermatozoa lasts during a period the length of which depends on whether a latent period is present or not, the postmarine age of the oyster, the density of the water, the temperature, the presence or absence of eggs, the age of the eggs if present, and whether the oyster has been freshened or not.

(32) Oysters with latent period have spermatozoa with decreased periods of activity.

(33) Fresh spermatozoa in their native sea water are active over 5 hours.

(34) This period is shortened in proportion to the postmarine age, in which (*a*) the number of days before the oyster is opened count as nearly equal in influence to (*b*) those that have elapsed since the oyster was opened. (By the end of a week the period is reduced to a quarter of an hour, but (*c*) conditions of temperature and moisture affect the result. The above experiments were performed upon oysters subjected to an average of 75° F., and moderately shielded from evaporation after opening.)

(35) Densities of salt water above 2 per cent shorten the active period to about a quarter of an hour, when 3½ per cent is reached.

(36) Densities weaker than 1⅞ per cent (or thereabouts) shorten the period to the same extent when one fourth per cent is reached.

(37) Postmarine age tends to shift the optimum strength of solution up the scale. For oysters nearly a week old the optimum is above 3 per cent instead of being below 2 per cent, as for fresh spermatozoa.

(38) Increase of temperature increases the activity but shortens the period. The practical limit (a period of a few minutes duration) is reached between 100° and 110° F.

(39) The optimum temperature for spermatozoid activity lies, roughly estimated, at 85°. (Lower limits not yet ascertained.)

(40) When spermatozoa are infused into water containing eggs their activity is increased, but the period is shorted one half.

(41) The fresher the eggs the greater their effect in shortening this period, but the two parts of postmarine age, viz, the days before opening and the days after opening, have unequal influence. Days after opening have less effect to shorten the period than days before opening.

(42) Freshening of oysters reduces the vitality of spermatozoa.

(43) The ability of spermatozoa to fertilize eggs decreases with postmarine age, and after 2 or 3 days the results are no longer satisfactory, although development is caused for some time later, yet this development shows a gradually descending scale of power as age increases.

(44) In 2 or 3 days the active period of spermatozoa is reduced one half; it follows that spermatozoa can suffer a weakening of 50 per cent of their vitality before losing the power to cause at least fair results in fertilization and development.

The eggs.—(45) Eggs are, at every point where environment influences them, more sensitive than spermatozoa.

(46) Eggs do not survive the death of the oyster unless the oyster be opened fresh.

(47) In oysters over 2 days old the eggs fail to produce embryos but rapidly decompose in the sea water (oyster still alive).

(48) Fresh eggs, unfertilized, remain in sea water for several days before yielding to decomposing forces.

(49) In solutions weaker than normal and in proportion to the dilution, fresh eggs decompose rapidly, passing through stages of swelling.

(50) In solutions stronger than normal, fresh eggs shrink, and finally also decompose with rapidity.

(60) Freshening of oysters acts very strongly to produce deterioration of eggs. Sometimes the eggs are as far gone when the oyster is first received as if the oyster (unfreshened) had been kept over 2 days.

(61) Eggs in oysters of only 1 day's postmarine age show (*a*) a great decrease in the number of eggs fertilizable, and (*b*) a partial and abortive development.

(62) Fresh eggs can remain in normal sea water over an hour before fertilization without losing the power of being fertilized and of developing.

(63) Some partial and abnormal development takes place even after 2¼ hours' soaking before fertilization.

(64) Solutions weaker or stronger than normal (*a*) decrease the period eggs can remain unfertilized without deterioration, or (*b*) if the period be the same, the results in development are correspondingly unsatisfactory, poor, or *nil*.

(65) Temperatures favorable to development range from 70° to 100°, with a probable optimum near 85° F.

(66) Increase in temperature rapidly increases the rate of development by about double for every 10°.

Embryos.—(67) Embryos can not be readily kept to the time of fixation without the assistance of a *claire* to furnish food.

(68) Embryos seem to be attacked by the infusorial parasites from the stomach, etc., of the adult oyster.

(69) At average temperatures vigorous embryos are all at the surface from one half to three quarters, or 1 day, and can be readily separated from débris and sediment at such time.

(70) Many embryos fail to become free-swimming.

(71) No satisfactory way of separating good eggs from bad ones in oyster culture was discovered.

(72) Eggs sink in sea water at a rate of nearly 1 foot per hour. (This can be taken advantage of in cleaning eggs by stratification.)

(73) Spawn is dispersed mainly by tidal currents during the short period the embryo swims at the surface.

(74) (*a*) The temperature of the water at Key Port was favorable to a set as judged by our records and experiments, and (*b*) a set was reported to have occurred—the first for many years.

(75) The saltness of the water at Key Port is close to the upper extreme of density for oyster culture, and can be weakened to 1.5 per cent, if not lower, without producing any unfavorable results so far as a "set" is concerned.

(76) Embryos are more delicate than their infusorial enemies.

(77) Embryos do not stand a sudden transfer into water weaker or stronger than $1\frac{1}{2}$ to 2 per cent without being greatly weakened.

REPORT OF BOTANIST, B. D. HALSTED, D. SC. (pp. 321–453, plates 24, fig. 6).—This includes an investigation of the causes of the failure of the peach crop in 1890, the effect of wet weather at the time of blooming on the setting of fruit, notes on fungous diseases, and a list of weeds of the State.

Observations in peach orchards (pp. 323–327).—A list of questions addressed to peach growers in the State is given from Special Bulletin L of the station (see Experiment Station Record, vol. II, p. 501), together with a summary of the replies received. In many cases the answers show great variety of opinion and practice, though in the following cases there was a much nearer approximation to unanimity: (1) In nearly all instances the peach orchard was naturally well drained; (2) the average tillage of the peach orchard is about 3 years of hoed crop or buckwheat one season, and afterward clean culture; (3) The majority of the orchards were without forest or other protection; (4) "fully 75 varieties are named, of which Smock, Crawford Late, Reeves, Pride of Franklin, Selway, Morris Rare Ripe, Old Mixon, President, and Mountain Rose are among those most generally grown"; (5) "as a rule the injury did not extend beyond the buds, but in some cases the upper ends of the branches suffered"; (6) age did not make constant difference as regards amount of injury; (7) "it was generally agreed that the excessive autumn rains, warm winter, cold snap on March 5 to 8, and frosts of April 18 were the chief reasons which combined to ruin the peach crop the past season."

Microscopic study of peach buds (pp. 327–330).—Notes and illustrations are given to show the normal condition of the dormant peach bud in winter, and of the buds as prematurely developed by warm weather and afterwards as injured by the cold.

Influence of rainfall at blooming time upon subsequent fruitfulness (pp. 330–332).—Brief notes are given on experiments in continuation of those recorded in the Annual Report of the station for 1889 (see above, p. 297). Strawberries kept constantly wet by frequent sprinkling during the time of flowering produced fewer and more irregular berries than adjacent plants that were not sprinkled. Plants covered by canvas also set fewer berries than those left uncovered. The flowers on an apple tree kept wet by spraying failed to set fruit, although surrounding trees of the same kind which were dry produced a full crop.

Experiments on cranberry diseases (pp. 332–339).—As the result of

investigations reported in Bulletin No. 64 of the station (see Experiment Station Record, vol. I, p. 263) on the cranberry gall fungus (*Synchytrium vaccinii*), an act was passed by the State legislature authorizing the officers of the station to enter upon any lands bearing vines or plants affected with injurious fungous growths and destroy the same by fire or otherwise. The full text of this act is given in the report. The bog in which the gall fungus was discovered was treated by withholding the water from the bog during the winter. This had a good effect, although in those parts of the bog which could not be kept dry the gall fungus was present in great abundance.

Several experiments with fungicides, including sulphate of copper, sulphate of iron, flowers of sulphur, and lime are reported, but no decisive results were obtained. Experiments by J. P. Goldsmith in covering bogs infected with the scald with earth to the depth of about an inch, have indicated that this method of treatment will materially decrease the ravages of the scald.

Fungous diseases of the sweet potato (pp. 339–345).—A reprint of the concluding paragraphs of Bulletin No. 76 of the station (see Experiment Station Record, vol. II, p. 416). Field experiments with flowers of sulphur, sulphate of copper, air-slaked lime, gas lime, common salt, and carbonate of lime for the soil and black rots of sweet potatoes, were conducted by several growers, but without decisive results.

Fungous diseases of various crops (pp. 345–366).—This includes notes on the fungous diseases which injured variousfield crops in the State in 1890, as follows: *Potatoes.*—Potato rot (*Phytophthora infestans*), a disease thought to be due to bacteria, and potato scab. *Cabbages.*—Club root (*Plasmodophora brassicæ*), a mildew (*Peronospora parasitica*), and black mold (*Macrosporium brassicæ*). *Radishes.*—Club root (*Plasmodophora brassicæ*) and white mold (*Cystopus candidus*). *Turnips and carrots.*—A root rot caused by an undetermined fungus. *Salsify.*—A root rot due to bacteria, which also injured turnips, carrots, and onions. *Onions.*—A botrytis (probably *Botrytis parasitica*), onion smut (*Urocystis cepulæ*), onion vermicularia (*Vermicularia circinans*), and black mold (*Macrosporium* sp.). *Spinach.*—Besides the species of fungi referred to in Bulletin No. 70 of the station (see Experiment Station Record, vol. II, p. 241), a leaf blight (*Cercospora flagilliformis*, E. & Hals.). *Eggplants.*—Leaf spot (*Phyllosticta hortorum*), ashy mold (*Botrytis fasicularis*), and anthracnose (*Glœosporium melongenæ*, E. & Hals.). *Peppers.*—Two species of anthracnose (*Glœosporium piperitum* and *Colletotrichum nigrum*, E. & Hals.) and a leaf spot (*Phyllosticta*). *Horse-radish.*—A leaf spot (*Septoria armoraceæ*) and a white mold (*Ramularia armoraceæ*). *Hollyhock.*—Rust (*Puccinia malvacearum*), leaf spot (*Cercospora althæina*), and *Colletotrichum malvarum*. *Violets.*—Leaf spot (*Cercospora violæ*), *Phyllosticta violæ*, a mildew (*Peronospora violæ*), anthracnose (*Glœosporium violæ*), and a white mold (*Zygodesmus albidus*, E. & Hals.). A number of other diseases of the violet were observed, and the whole

subject will be treated in a future bulletin. *Carnations.—Septoria dianthæ* and *Vermicularia subeffigurata. Mignonette.—Cercospora residæ. Plum and cherry trees.*—Black knot. A brief summary of information, which was given in more detail in Bulletin No. 78 of the station (see Experiment Station Record, vol. II, p. 501).

Fungicide and insecticide combined.—A brief account of successful experiments by J. M. White with Climax Insect Poison (a preparation of London purple and starch) and ammoniacal carbonate of copper for the codling moth and fungous diseases of pears, apples, and grapes.

Nematodes as enemies to plants (pp. 366–370).—Nematodes were observed in the roots of violets, oats, and roses, and upon the leaves of chrysanthemums, coleus, lantana, and bouvardia. Specimens of the nematodes attacking the leaves of the above-mentioned plants were submitted to G. F. Atkinson of the Alabama College Station, who reports that they are probably of the same species, for which he proposes the name of *Aphelenchus foliicoleus.*

Weeds of New Jersey (pp. 370–453).—An explanation of the scale of points for grading weeds according to their harmfulness, which is proposed by the author in Bulletin No. 52 of the station (see Experiment Station Record, vol. I, p. 130); lists of 20 or more of the worst weeds of New Jersey, in the order of their vileness, by fourteen different observers in the State, with partial lists by five other persons; an article on the weeds of Sussex County, New Jersey, by T. Lawrence and W. M. Van Sickle; and a preliminary classified list of 265 species of weeds found in New Jersey, with an index to their common names. Twenty-four of the leading kinds of weeds of the United States are described and illustrated in plates taken from the annual reports of this Department. The 30 worst weeds of New Jersey in the order of their vileness, as determined from the reports of the observers above referred to, are as follows: Wild carrot (*Daucus carota*), ox-eye daisy (*Chrysanthemum Leucanthemum*), sorrel (*Rumex acetosella*), plantain (*Plantago major*), curled dock (*Rumex crispus*), ragweed (*Ambrosia artemisiæfolia*), Canada thistle (*Cnicus arvensis*), purslane (*Portulaca oleracea*), burdock (*Arctium lappa*), toadflax (*Linaria vulgaris*), wild onion (*Allium vineale*), mayweed (*Anthemus cotula*), goosefoot (*Chenopodium album*), yellow daisy (*Rudbeckia hirta*), pigweed (*Amarantus chlorostachys*), quitch grass (*Agropyrum repens*), horseweed (*Erigeron canadensis*), beggar's ticks (*Bidens frondosa*), water pepper (*Polygonum hydropiper*), shepherd's purse (*Capsella bursa-pastoris*), pepper grass (*Lepidium virginicum*), rib grass (*Plantago lanceolata*), milkweed (*Asclepias syriaca*), dandelion (*Taraxacum officinale*), burr grass (*Cenchrus tribuloides*), corn cockle (*Lychnis githago*), velvet leaf (*Abutilon avicennæ*), thistle (*Cnicus lanceolatus*), chickweed (*Stellaria media*), black mustard (*Brassica nigra*). Of the 265 species of New Jersey weeds 135 are native and 130 have been introduced from abroad; but of the 20 worst weeds only 4 are native. As to length of life, the distribution of the species is as follows:

Annuals 105, biennials 34, and perennials 126. The following table shows the distribution "according to the somewhat arbitrary scale of worst, bad, and indifferent weeds":

	Annuals.	Biennials.	Perennials.	Total.
Worst weeds	30	7	17	54
Bad weeds	44	15	39	98
Indifferent weeds	31	12	70	113
Total	105	34	126	265

REPORT OF ENTOMOLOGIST, J. B. SMITH (pp. 455–528, figs. 30).—This contains brief general notes on the work of the year; an abstract of an article on insecticides and their use, published in Bulletin No. 75 of the station (see Experiment Station Record, vol. II, p. 415); compiled notes on the following insects affecting sweet potatoes, with suggestions as to remedies: Two-striped sweet potato beetle (*Cassida bivittata*), golden tortoise beetle (*Coptocycla aurichalcea*), mottled tortoise beetle (*Coptocycla guttata*), and black-legged tortoise beetle (*Cassida nigripes*); original and compiled notes on the squash borer (*Melittia ceto*), striped cucumber beetle (*Diabrotica vittata*), boreal ladybird (*Epilachna borealis*), and melon aphid (*Aphis cucumeris*) as insects injurious to squash and melon vines; eight-spotted forester (*Alypia 8-maculata*) as injurious to the grape; katydid (*Microcentrus retinervis*) and tip worm as injurious to cranberries; black peach aphis (*Aphis persicæ-niger*) and peach borer (*Sannina exitiosa*) as injurious to peach trees; wheat louse (*Siphonophora avenæ*), white cabbage butterfly (*Pieris rapæ*), elm leaf beetle, curculio, apple borer, army worm, corn worm, and clover leaf beetle (*Phytonomus punctatus*).

Special Bulletin K of the station (see Experiment Station Record, vol. II, p. 418) gave an account of a number of insects injurious to cranberries in 1889. In 1890 unusual injury was done to cranberries by katydids. Experiments in cranberry bogs at Jamesburg, New Jersey, indicated that drawing the water from the bogs in the spring and afterwards letting it on again would do much towards preventing the ravages of these insects. Spraying infested patches of the bogs with London purple and Paris green was found to be decidedly beneficial. But "to make spraying successful against these cranberry pests, it is necessary to make the application just as soon as they are hatched and before they get the leaves webbed up." Experiments by the author prove, in his judgment, that punctures by the curculio will not cause the dropping of apples; that though the eggs may hatch, the larvæ will not develop in growing apples; that a decaying condition is necessary to bring them to maturity; and that they will not develop in withered fruit when no decay is started. This result enforces the necessity of clearing the orchards of fallen fruit, and especially early in the season.

APPENDIX (pp. 529–549).—This contains the acts of the State legislature relating to the station, to the prevention of the spread of fungous diseases of plants, and to the inspection of fertilizers; directions for sampling fertilizers and feeding stuffs; the order of station work during the year; and a catalogue of the bulletins issued by the station from its organization (1880) to December 31, 1890. Abstracts of the bulletins for 1889 and 1890 may be found in Experiment Station Record, vols. I and II.

THIRD ANNUAL REPORT OF THE NEW JERSEY COLLEGE STATION FOR THE YEAR ENDING JUNE 30, 1890 (pp. 551–556).—This contains a brief statement as to the organization of the station.

New Jersey Stations, Bulletin No. 83, September 15, 1891 (pp. 35).

ANALYSES AND VALUATION OF FERTILIZERS, E. B. VOORHEES, M. A.—This contains analyses of 212 brands of "complete fertilizers" collected within the State during 1891. These analyses "furnish direct answers to the following questions:"

(1) Do the analyses of fertilizers give any definite information as to the kind of materials used in making the different brands?

(2) In the number of brands on the market, is there a variation in composition sufficient to fulfill special soil and crop requirements?

(3) Do the manufacturers as a rule furnish in their mixtures the amount of plant food claimed in the guaranties?

(4) When a given brand is found to give satisfaction is there any evidence that it will not change in composition from year to year?

(5) Are the station's valuations of the different brands of any value as a guide in their purchase?

(6). Is it more advantageous to buy high-grade than low-grade fertilizers?

It is claimed that while the analysis does not furnish complete information as to the source and quality of the materials entering into the composition of a compound fertilizer, "an analysis, rightly interpreted, may be of great service in the selection of the most efficient brands." Wide differences were found in the composition of special crop fertilizers prepared by different manufacturers.

For instance, there are 44 different brands for potatoes, varying widely in composition both as regards quantity and quality of plant food. A tabulation of these brands shows that the nitrogen varies from 0.76 to 5.33 per cent, available phosphoric acid from 2.64 to 9.77 per cent, and potash from 2.09 to 12.22 per cent. This would seem to indicate either that manufacturers are not a unit as to their ideas of the special requirements of the potato, or that no particular significance should be attached to special-crop brands as now prepared by the different manufacturers.

With regard to the relation between the guaranty and the results of analysis, 114 (54 per cent) of the 212 brands analyzed were found to be below the guaranty with respect to one or more ingredients. This leads the author to conclude that "the guaranty is not a safe guide as to the composition of more than one half of the brands on the market in the State." However, "a careful study of the published analyses of

fertilizers is valuable in that it shows which of the manufacturers sell in a mixture at least as much of the valuable ingredients as they claim." By a comparison of the analyses of the brands of three large firms for the past 5 years it was found that "the composition is practically constant both in regard to proportion and amount of plant food contained."

Of the 212 brands reported on, the selling price of 2 was below the station's valuation; that of 128, or 60 per cent of the whole, was from 26 cents to $10 greater than the station's valuation; that of 65, or 31 per cent, was from $10 to $15 greater; that of 14 was from $15 to $20 greater; and that of 2 was more than $20 per ton greater.

The station's valuations are of great service in the purchase of mixed fertilizers, when used in connection with the information given by analyses.

[The difference is pointed out between high-grade and low-grade fertilizers.]

The advantages to be derived from the use of high-grade fertilizers are, (1) a direct saving in cost per pound of the actual fertilizing ingredients; and (2) a reasonable certainty that the quality of the ingredients is such as to produce their full agricultural effect.

New York State Station, Bulletin No 33 (New Series), July, 1891 (pp. 23).

FERTILIZERS, P. COLLIER, PH. D. (pp. 533–553).—This is a continuation of the popular bulletins published by the station, and contains an explanation of the terms of chemical analysis, remarks on commercial valuation of fertilizers, a tabulated statement of the composition of various chemical compounds, schedule of trade values of fertilizing ingredients for 1891, and analyses of 30 samples of commercial fertilizers collected within the State during 1891.

New York State Station, Bulletin No. 34 (New Series), August, 1891 (pp. 48)

COMPARISON OF DAIRY BREEDS OF CATTLE WITH REFERENCE TO PRODUCTION OF BUTTER, P. COLLIER' PH. D. (pp. 557–602).—This bulletin is a continuation of Bulletins Nos. 18 and 21 of the station (see Experiment Station Record, vol. I, p. 269, and vol. II, p. 243), and is the beginning of the record of milk production in the test of different breeds, the two previous bulletins having been occupied with a description of the cows, fluctuations in live weight, amounts of food consumed, etc. The record includes for the first 6 months of the period of lactation of each cow the amount of fat in 100 pounds of milk, and the proportion of this occurring in cream, skim milk, buttermilk, and in the butter; data as to the fat recovered and lost; the relations of milk, cream, and butter; the daily yields of milk and of butter; the monthly yields of dairy products; the temperature and time of churning; and the relative number and size of fat globules. In addition to these data a summary is given for the cows of each breed, from which the following is taken:

Tabulated summary of results for the first 6 months of lactation.

	Ayrshires.	Guernseys.	Holdernesses.	Holsteins	Jerseys.
Pounds of fat in 100 pounds of milk	3.50	5.07	3.69	3.71	5.61
Pounds of fat in skim milk from 100 pounds of milk	0.38	0.23	0.44	0.85	0.38
Pounds of fat in cream from 100 pounds of milk	3.12	4.84	3.25	2.86	5.24
Pounds of fat in buttermilk from 100 pounds of milk	0.09	0.05	0.06	0.16	0.08
Pounds of butter from 100 pounds of milk	3.47	5.51	3.61	2.78	5.78
Per cent of fat in milk recovered in cream	89.4	95.50	88.00	75.70	93.40
Per cent of fat in milk lost in skim milk	10.6	4.50	12.00	24.30	6.60
Per cent of fat in milk lost in buttermilk	2.4	0.70	1.50	5.30	1.50
Per cent of fat in milk recovered in butter	81.8	92.50	84.00	64.30	87.60
Pounds of milk required to make 1 pound of butter	29.4	18.40	28.20	40.00	17.50
Pounds of milk required to make 1 pound of cream	5.28	3.73	5.57	7.89	4.01
Pounds of cream required to make 1 pound of butter	4.73	4.96	5.81	5.05	4.45
Per cent of fat in cream	19.50	18.08	18.05	20.47	21.05
Pounds of milk produced per day	19.7	16.50	15.70	27.10	16.40
Pounds of butter produced per day	0.71	0.90	0.56	0.70	0.91
Time of churning (in minutes)	33	30	67	65	51
Relative size of fat globules	536	863	498	523	1087

Although no general conclusions are yet reached, several points of interest seem to have been indicated by the results.

Observations.—While in the foregoing table the largest amount of fat in the milk produces the largest amount of butter, it does not hold good that the amount of butter is, in every case, proportional to the amount of fat in the milk. While the amount of fat in the milk of the Holsteins stands third, the amount of butter stands fifth. The amount of butter produced from 100 pounds of milk depends upon the amount of fat lost in skim milk and buttermilk, as well as upon the amount of fat originally in the milk. * * * While the Jersey milk contains a larger amount of fat and makes a larger amount of butter than the milk of the Guernseys, we see from this table that the Guernseys lost a smaller proportion of fat in both skim milk and buttermilk than did the Jerseys; that is, the creaming and churning efficiency is greater in the case of Guernseys, or, we may say, the Guernseys make relatively more of the fat in their milk, in so far as the results at hand indicate. The amount of fat in the milk of the Ayrshires was lowest, while in creaming and churning efficiency the Ayrshires stand third. * * * As the period of lactation advances the creaming and churning efficiency seems to diminish, that is a larger proportion of fat is lost in skim milk and buttermilk. It remains to be seen how fully our future data will confirm this. * * *

One curious result, which does not seem to agree with the observations of others and which may be changed by more extended observations, is that the amount of fat in the cream does not seem to be in most cases related to the amount of fat in the milk. Thus in richness of milk the order is, (1) Jerseys, (2) Guernseys, (3) Holsteins, (4) Holdernesses, (5) Ayrshires; while in richness of cream the order is, (1) Jerseys, (2) Holsteins, (3) Ayrshires, (4) Guernseys, (5) Holdernesses. * * *

While the average temperature of churning does not vary greatly for the different breeds, the time of churning varies from 30 to 67 minutes. The advance of the period of lactation appears from the data at hand to be accompanied by a higher degree of temperature of churning. * * * There appears to be a general relation between the relative number of fat globules and the creaming and churning efficiency, the milk containing the smaller number being more efficient for butter making. In regard to the relative size of the fat globules, the larger the size the more efficient the creaming and churning. * * *

So far as we can judge from the data now on hand, advance of the period of lactation seems to be accompanied by an increase in the number and a diminution in the size of the fat globules.

New York State Station, Bulletin No. 35 (New Series), August, 1891 (pp. 27).

SOME OF THE MOST COMMON FUNGI AND INSECTS, WITH PREVENTIVES (pp. 603–627).—Popular notes on the following fungi and insects, with suggestions as to remedies: Anthracnose of grapes (*Sphaceloma ampelinum*), apple scab (*Fusicladium dendriticum*), pear scab (*F. pyrinum*), black knot of plum and cherry (*Plowrightia morbosa*), black rot of grapes (*Læstadia bidwellii*), downy mildew (*Peronospora viticola*), powdery mildew of grapes (*Uncinula spiralis*), grape leaf blight (*Cercospora viticola*), white rot and bitter rot of grapes, strawberry leaf blight (*Ramularia tulasnei*), orange rust and anthracnose of the raspberry (*Glæosporium necator*), flat-headed apple tree borer (*Chrysobothris femorata*), round-headed apple tree borer (*Saperda candida*), oyster-shell bark louse (*Mytilaspis pomorum*), apple tree tent caterpillar (*Clisiocampa americana*), forest tent caterpillar (*C. disstria*), yellow-necked apple tree caterpillar, red-humped apple tree caterpillar, fall webworm (*Hyphantria cunea*), cankerworm (*Anisopteryx vernata*), leaf rollers and folders, bud worms, apple tree bucculatrix (*Bucculatrix pomifoliella*), apple tree aphis (*Aphis mali*), apple curculio (*Anthonomus 4-gibbus*), apple maggot (*Trypeta pomonella*), codling moth (*Carpocapsa pomonella*), plum curculio (*Conotrachelus nenuphar*), quince curculio (*C. cratægi*), peach tree borer (*Sannina exitiosa*), strawberry root borer, strawberry crown borer (*Tyloderma fragariæ*), raspberry root borer (*Bembecia marginata*), raspberry cane borer, tree cricket (*Œcanthus niveus*), imported currant borer, American currant borer (*Pristiphora grossulariæ*), imported currant worm (*Nematus ventricosus*), and currant worm.

New York State Station, Bulletin No. 36 (New Series), September, 1891 (pp. 20).

SMALL FRUITS (pp. 629–646).—Notes on strawberries, raspberries, blackberries, currants, and gooseberries, with brief accounts of their insect and fungus enemies.

Strawberries (pp. 631–639).—Brief descriptive notes on 40 varieties, accounts of the strawberry root borer, crown borer, and leaf blight, with suggestions as to remedies, and a list of the 26 most productive varieties at the station in 1891.

We should advise, if planting for a fancy market, the following varieties: *Early.*—Haverland and Van Deman. *Medium.*—Bubach, Sharpless, and Burt. *Late.*—Crawford, Middlefield, Parker Earle, and Gandy. For a distant market, Van Deman, Stayman No. 1, and Burt. For a near-by market the last-mentioned varieties, with the addition of Beder Wood, Parker Earle, and possibly Mount Vernon. * * *

In 1891 the matted rows of Burt yielded at the rate per acre of 11,344 quarts; Beder Wood, 10,890; Greenville, 8,394; Parker Earle, 8,168.

Raspberries (pp. 639–642).—Brief descriptive notes on 6 of the newer varieties, and accounts of the blackcap orange rust, anthracnose, raspberry root borer, raspberry cane borer, and tree cricket, with

suggestions as to remedies. The Bordeaux mixture is being used at the station for the anthracnose with apparently beneficial results.

The earliest blackcap was the Carman, the latest the Ada, the most productive the Hilborn, with Smith Prolific next.

Of the red varieties, the earliest were Clark and Thompson Early Pride; the latest, Parry No. 2 and Miller Woodland; the most productive, Cuthbert [a fine shipping berry, which can be widely grown], Muskingum, Shaffer [especially recommended for canning], Clark, Thompson Early Pride, Stayman No. 5, Shaffer Pomona, and Genesee, in the order named.

The Caroline, an extremely hardy yellow variety, yielded more than any of the other varieties this year, and the Golden Queen (a yellow Cuthbert) gave also a large yield. Both of these varieties are of superb flavor but soft, and easily damaged because of their color. However they should be in every private collection.

Blackberries (pp. 642, 643).—Of the varieties tested at the station, Agawam, Erie, and Snyder are especially commended.

Currants (pp. 643, 644).—Fay Prolific (on light soils), Cherry, and Prince Albert (late) red varieties, and White Grape are excellent standard varieties. Brief mention is made of the imported currant borer, American currant borer, imported currant worm, American sawfly, and current spanworm, with suggestions as to remedies.

Gooseberries (pp. 644–646).—The foreign varieties, such as Industry, Triumph, Wellington Glory, and Roesch Seedling, grown at the station in 1891, kept entirely free from mildew, and bore an average of over 10 pounds of fruit per plant. During the past 3 years potassium sulphide (one half ounce to 1 gallon of water) sprayed at intervals of 18 to 20 days from the time the leaves began to unfold, prevented the development of mildew.

North Carolina Station, Bulletin No. 79, July 20, 1891 (pp. 22).

FACTS FOR FARMERS, W. F. MASSEY, C. E.—This, as the author states, is "a bulletin of information on scientific matters in plain language for unscientific readers," and treats of the underlying principles of plant growth and plant nutrition, manures, sources of fertilizing materials, etc.

North Carolina Station, Bulletin No. 79*a* (Meteorological Bulletins Nos. 21 and 22), August 15, 1891 (pp. 34).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JUNE AND JULY, 1891, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, monthly summaries, and tabulated daily record of meteorological observations by the North Carolina weather service. The bulletin is illustrated with maps of North Carolina showing the isothermal lines and the total precipitation at the stations in different parts of the State.

Ohio Station, Bulletin Vol. IV, No. 5 (Second Series), September 1, 1891 (pp. 18).

THE WHEAT MIDGE, F. M. WEBSTER (pp. 99–114, figs. 14).—A history of the observations on the wheat midge (*Diplosis tritici*), with transcripts of notes on the ravages of this insect in Ohio each year from 1847 to 1878, inclusive, taken from the reports of the State board of agriculture. Larvæ thought to belong to this species were observed under the sheaths of young plants. Adults were reared from the heads of rye in July and from Volunteer wheat from September 1 to November 3. The figures illustrating the bulletin are after Fitch.

Rhode Island Station, Bulletin No. 11, June, 1891 (pp. 18).

STATE FERTILIZER LAW, COMMERCIAL VALUE OF FERTILIZER STOCK, AND ANALYSES OF COMMERCIAL FERTILIZERS AND MISCELLANEOUS MATERIALS, H. J. WHEELER, PH. D. (pp. 131–146).—This includes analyses of twelve brands of commercial fertilizers, fresh horse manure, street sweepings from the city of Providence, meadow muck, wood ashes, waste liquid from a rendering establishment, and spring water; the schedule of trade values of fertilizing ingredients for 1891; remarks on the valuation of fertilizers; the text of the State fertilizer law; and a copy of a proposition made by the station to the State board of agriculture to make all analyses of commercial fertilizers and wood ashes called for by the fertilizer law, and to compile and publish the same. This proposition was accepted by the State board of agriculture, but at so late a date as to somewhat delay the work of collection and analysis for the current year.

METEOROLOGICAL SUMMARY, L. F. KINNEY, B. S. (p. 147).—Tabulated data on the weather from January 1 to July 1, 1891.

South Carolina Station, Second Annual Report, 1889 (pp. 353).

ACTS RELATING TO THE ORGANIZATION OF THE STATIONS (pp. 5–9).—Under this head are given the texts of the act of the general assembly of the State in 1886 establishing the South Carolina agricultural farms and station; the act of Congress of March 2, 1887, and the acts of the general assembly of the State accepting the provisions of the act of Congress, discontinuing the station at Columbia, and establishing the Clemson Agricultural College and a new station in connection with it.

REPORT OF ANALYST OF SOILS AND SEEDS, R. H. LOUGHRIDGE, PH. D. (pp. 11–43).—This report includes the tabulated results of mechanical and chemical analysis of the soils and subsoils of the experimental farms of the station at Spartanburg, Columbia, and Darlington,

and of sea island cotton and rice-land soils near the coast of South Carolina; a description of the methods of sampling and analysis used; a discussion of the results; and remarks on the requisites of a good soil, on soil analysis in general, with citations from different sources, and on the interpretation of the results of soil examinations, with Professor Hilgard's conclusions on the composition of soils as stated by him in the report on cotton culture, Tenth United States Census, vol. V. Samples were taken of soil and subsoil of each of the experimental farms, which were situated in three representative localities, and separate analyses were made of each sample. In addition to the results of the mechanical and chemical analyses, the calculated number of soil particles per gram of soil and their combined surface area are stated for each grade of the soil and subsoil of each farm. "In order to ascertain how much hygroscopic moisture was absorbed [by each grade of soil particles] from an atmosphere saturated with moisture, tests were made on a soil from the Spartanburg farm, which contained 11.2 per cent of ferric oxide, all of which was contained in the silt and clay." The different sized particles were exposed for a time at 70° F., and then the percentages of moisture lost by the different grades in heating at 200° C. were determined. The tabulated results indicate that the percentages of moisture given off "increase with the lessening diameters of the grains." The author concludes from this trial and from results obtained by Professor Hilgard that "ferric oxide clearly has a large influence in giving soils a large absorption coefficient."

REPORT OF VICE DIRECTOR, M. WHITNEY (pp. 44–96).

Meteorology and the physical properties of soils as related to plant growth and crop production (pp. 44–84 and 86–96).—This includes remarks on the value of the staple crops of the State for experimentation, on the soils of the State, and on the study of typical soils of the State. The investigations include laboratory experiments on the soils of the station farms, sea island upland cotton soils, and upland soils of different geological formations, supplemented by observations in the field and by meteorological studies. The scope of the work undertaken is indicated by the following brief outline: (1) Interpretation of the results of mechanical analysis, including studies on the number of particles in a unit weight or volume of soil, on the diameter of average-sized particles of soil and the mean arrangement of the particles, and on the surface area of particles, the latter showing the need of still further perfecting the method of mechanical analysis of soils; (2) on a movement of soil particles due to changing water content and changing temperature, as related to the growth of roots, and the physical action of manure, with the effect of barometric changes and vapor pressure on the same; (3) method for the determination of the moisture in the soil by electrical resistance; (4) on the movement of soil moisture, including the cause and laws of the movement, and the effect of temperature, manure, rain, cropping, and cultivation on this movement; (5)

calculation of the relative movement of soil moisture in different soils from the mechanical analysis; (6) calculation of the relative rate of evaporation and underdrainage from different soils from the mechanical analysis; (7) on the capillary value of different soils from the mechanical analysis; (8) effect of fineness and compactness on the water-holding power; (9) on the action of underdrains in the soil and on how they act; (10) on the flocculation and subsidence of clay particles; (11) on the swelling of clay when wet; (12) on the compacting of soils by rain; (13) on the physical action of manures and fertilizers; (14) a new form of soil thermometer, which registers the maximum and minimum temperature of a definite layer of soil; (15) the relation of the soil to heat as observed in the field in typical soils or under different conditions of cultivation and fertilization; (16) calculations of the relation of different soils to heat from the mechanical analyses, with the effect of the water content, cultivation, and cropping; (17) the actual temperature of different soils, with range, etc.; (18) study of the loss of heat from different soils, as calculated from the mechanical analysis and as determined with the radiation thermometer; (19) specific heat of typical soils; (20) temperature of the air and soils, and amount of moisture in these most favorable for plant growth; (21) the estimation of the actual amount of moisture in the soils from time to time; (22) influence of meteorological conditions on grain production, as explaining low average yield of grain at the South, on the distribution of crops throughout the State, and on the growth and ripening of crops; (23) amount and intensity of sunshine available for the crop; (24) effect of wind movement on plant growth, especially as to the amount of ammonia supplied to crops.

The following topics are discussed in some detail: The interpretation of the results of mechanical analysis of soils, movement of soil moisture, physical action of manures in improving the drainage of soils, calculation of the rate of movement of soil moisture, and the relation of meteorological conditions to the growth of the cotton crop.

Meteorological data as recorded for each month from November, 1888, to June, 1889, are reprinted from Bulletin No. 7 (new series) of the station (see Experiment Station Record, vol. I, p. 312). These data include the maximum, minimum, and mean temperatures of the air; daily range in temperature of the air; mean height of the barometer; pressure of water vapor in the atmosphere; mean dew-point; mean relative humidity; rainfall; the readings of the solar radiation (maximum) and terrestrial radiation (minimum) thermometers; the difference in temperature between the terrestrial radiation thermometer and the dew-point; daily wind movement; the maximum, minimum, and mean temperatures of the soil (3–9 inches); and the mean weekly temperatures of the soil at different depths. A comparison by seasons is made of the mean meteorological data for Massachusetts, New York, Pennsylvania, South Carolina, Georgia, Alabama, Mississippi, Ohio, Illinois, Indiana, Iowa, Michigan, Minnesota, and Wisconsin.

On the development of cotton roots (pp. 84–86).—Observations on the distribution, extent, and development of the roots of the cotton plant, reprinted from Bulletin No. 7 (new series) of the station (see Experiment Station Record, vol. I, p. 314).

REPORT OF BOTANIST AND ENTOMOLOGIST, E. A. SMYTH, jr., B. A. (pp. 97–108).—Notes on *Pieris protodice*, *P. monuste*, several species of the genus *Colias*, *Neonympha canthus*, *Pamphila ethlius*, *Leucania unipuncta*, and the following insects attacking the fig: *Allorhina nitida*, *Ptychodes trilineatus*, *Libythea bachmanni*, *Apatura celtis*, *A. clyton*, *Grapta interrogationis*, and *Pyrameis atalanta*. There is also an account of the weed *Helenium autumnale*.

REPORT OF CHEMIST, W. B. BURNEY, PH. D. (pp. 109–155).

Feeding stuffs (pp. 109–155).—A popular discussion is given of the nutrition of farm animals, of the nutritive ingredients of feeding stuffs and their functions, and of feeding standards; an explanation of the scientific terms used in the discussion of the subject of feeding, together with a large amount of tabulated data, including analyses of numerous American feeding stuffs, taken from the compilation published by Dr. E. H. Jenkins in the Annual Report of the Connecticut State Station for 1888; the coefficients of digestibility of numerous materials, taken from the Annual Report of the Connecticut State Station for 1886; and the calculated amount of food nutrients required by different kinds of animals under different conditions, per head and per 1,000 pounds live weight, taken from German sources. In addition to the above, analyses made at the station are given of the following materials: Oats, oat straw, rice and its by-products (*i. e.* clean rice, rough rice, rice flour, rice straw, and rice chaff), Texas blue grass, crowfoot (*Eleusine aegyptiaca*), ragweed, corn bran, China berries, and ramie (plant and stems) with reference to both food and fertilizing ingredients; and cotton-seed meal, cotton-seed hulls, and wheat bran with reference to food ingredients.

Analyses of fertilizing materials (pp. 153–155).—Analyses of pine straw (needles), superphosphate, dried blood, muriate of potash, nitrate of soda, Thomas slag, calcined marl, and whole cotton seed.

REPORT OF FIRST ASSISTANT CHEMIST, J. B. MCBRYDE, B. A. (pp. 156–180).—*Chemical statistics of the Indian corn crop of South Carolina* (pp. 156–169).—In this article on the value of the Indian corn plant the remarks of the author are illustrated by analyses of numerous samples of corn (kernels), corncobs, cornshucks (husks), and corn silage with reference to both food and fertilizing ingredients; a statement of the relation of parts of the plant, prepared from observations on the crops grown during 1889 on thirteen different farms; and a comparison of the analyses of South Carolina corn with those of Northern and Western-grown corn, reported in Bulletin No. 96 of the Connecticut State Station (see Experiment Station Record, vol. I, p. 15), and the Annual Report of the Massachusetts State Station for 1889 (see Experiment Station Record, vol. II, p. 579).

The author concludes, with regard to the relation of the parts, that "(1) in an average crop of Indian corn the ear is by weight approximately one half of the entire crop; (2) about four fifths of the ear is grain; and (3) about one half of the stover is stalk."

The cowpea as a forage crop (pp. 169–179).—This is a chemical study of the cowpea plant with reference to both food and fertilizing ingredients. The composition (including fertilizing ingredients) is given of pea-vine hay cut when in bloom, when the pods were forming, and when the pods were formed; the fertilizing ingredients in the roots and stubble are stated; and the hay is compared with oats (grain and straw) and corn (kernels and stover) with regard to composition and the total yield of nutrients, digestible nutrients, and fertilizing ingredients per acre, assuming a yield of 40 bushels of oats, 30 bushels of corn, and 3.6 tons (the yield observed) of cowpea vines.

The pea crop lacks only 481 pounds of containing as much digestible organic matter as the other two crops combined. It contains five times as much crude protein and fat (the most valuable constituents of feeding stuffs) as either oats or corn, and three times as much as their sum. To equal the yield of the cowpea vines in digestible protein (976 pounds) would require 300 bushels of oats including the straw, or 175 bushels of corn including the fodder.

Of digestible carbohydrates the pea affords nearly twice as much as the oats and a little more than the corn. It must be borne in mind that the figures given for oats and corn represent the entire crop, the straw and stover being included.

The relative amounts of fertilizing ingredients per acre contained in the above-mentioned crops are given as follows:

Fertilizing constituents in crop per acre.

	Cowpea vines.	Oats (grain and straw).	Corn (kernels and stover).
	Pounds.	*Pounds.*	*Pounds.*
Nitrogen	203	35	45.0
Phosphoric acid	33	12	14.4
Potash	153	48	45.9
Valuation	$41.82	$8.55	$10.14

As the cowpea obtains a part of its nitrogen from the atmosphere and a part, together with some of its phosphoric acid and potash, from the subsoil, the large amount of these constituents left in its roots and stubble, and dead leaves dropped by the plant, tend to enrich instead of impoverish the soil; in other words, its power of collecting and storing fertilizing materials from sources beyond the reach of the cereals makes the cowpea a valuable remedial crop.

Composition of soja beans (pp. 179, 180).—Analyses (including fertilizing constituents) of soja-bean vines and of hulls and vines after the beans had been threshed.

REPORT OF VETERINARIAN, W. B. NILES, D. V. M. (pp. 181–192).—A reprint of an account of investigations on hog cholera, published in Bulletin No. 6 (new series) of the station (see Experiment Station Record, vol. I, p. 312), with brief statements regarding experiments with

sterilized cultures for the prevention of the disease, and notes on Southern cattle plague.

FIELD EXPERIMENTS, J. M. MCBRYDE, PH. D. (pp. 193–344).—The probable errors in plat experiments are discussed, and a description is given of the field experiments with oats, wheat, corn, cotton, and miscellaneous crops made during 1889 at the experimental farms at Columbia, Spartanburg, and Darlington. Except in cases specified hereinafter, the experiments were duplicated on the three farms. The experiments are in many instances in continuation of those reported in Bulletin No. 5 (new series) and in the Annual Report of the station for 1888 (see Experiment Station Record, vol. 1, p. 146, and Experiment Station Bulletin No. 2, part 2, p. 142). In the majority of cases twentieth-acre plats were used.

Experiments with oats (pp. 198–206).—These consist of experiments with fertilizers for oats and variety tests, and were made at all three farms. "On account of the unfavorable season, and especially of the prolonged spring drouth, the crop at all three farms was almost a total failure." The crops at Columbia were destroyed by fire a few days after harvesting. The results obtained at the other two farms are tabulated "in order to preserve the records of our tests."

Experiments with wheat (pp. 206–209).—These were confined exclusively to the Spartanburg farm, and were a continuation of those of the previous year, *i. e.* tests of fertilizers and of varieties. The data for 1888 and 1889 are tabulated. As mentioned above "the season was unfavorable to small grain," but the points noticed in the fertilizer tests of the 2 years are given as follows:

(1) The separate applications of potash, nitrogen, etc., were without effect.

(2) The value of the potash was comparatively slight.

(3) Phosphoric acid was of marked benefit to the crop; when used with the other constituents it was clearly the most important or dominant element.

(4) Nitrogen in combination added largely to the yield.

(5) The half amount or dose of nitrogen was by no means as effective as the full amount [calculated amount contained in a crop of 50 bushels of grain per acre].

(6) The mixed nitrogen [three fourths nitrate of soda and one fourth cotton-seed meal] gave much the best results. The land was very thin and hence the soil was deficient in nitrogen. On account of the absence of this element during the winter the growth of the plants on the other plats was feeble and slow. The addition of some nitrogen in the shape of cotton-seed meal in the fall greatly improved the growth during the winter and early spring, and the superiority thus secured was maintained to the end.

In the variety test, as in 1888, "the South Carolina-grown wheats (Red May and Fultz) gave better returns than the Virginia-grown."

Experiments with corn (pp. 210–268).—"The experiments with corn begun in 1888 were continued in 1889 at all three farms, and included tests of fertilizers (in general), nitrogenous manures, phosphatic manures, modes of applying fertilizers, modes of planting, modes of cultivation, varieties, and rotations. The season of 1889 was very favorable for corn, and excellent crops were harvested throughout the State."

(1) *Fertilizers on corn.*—As in 1888, "in addition to the full amounts of potash, phosphoric acid, and nitrogen (*i. e.* the amounts of each contained in a crop yielding 30 bushels of grain per acre), smaller and larger amounts of each were tested." The yields in 1888 and 1889 are tabulated for each farm, as well as the averages for the three farms.

A comparison of the results for the 2 years shows that the fertilizers gave much better returns at Spartanburg and Darlington in 1889 than in 1888, the increase of yield in the former year amounting to from 75 to 100 per cent. * * * Applied separately or combined in twos the fertilizers gave very poor returns. Potash in small or half doses was of some little benefit. The full amount of phosphoric acid was called for but only half doses of nitrogen. Both constituents were of value to the crop.

Increasing the yield of any one or more of the constituents beyond a certain point (the full or theoretical amount) gave no corresponding increase in the crop. From a pecuniary standpoint but four of the applications gave profitable results.

(2) *Special nitrogen, phosphoric acid, and potash experiments.*—The separate series of experiments to compare the effects on corn of different nitrogen, phosphatic, and potash fertilizers, when each was used in amounts furnishing the same quantity of nitrogen, phosphoric acid, or potash, respectively, were continued in 1889 on all three farms. The results in yield of corn and stover are fully tabulated for each series. The indications from the 2 years' trials are given by the author as follows:

[Nitrogen.] (1) The corn crop does not respond to heavy applications of nitrogenous manures. Moderate amounts will probably give fair returns. In our tests 120 pounds of nitrate of soda proved as effective as 240 pounds; 168 pounds of dried blood as effective as 325 pounds, etc. (2) Of the nitrogenous fertilizers commonly used by our farmers (nitrate of soda, dried blood, cotton-seed meal, and cotton seed whole or ground) one kind appears to be about as effective on Indian corn as another, where equivalent amounts are applied. The employment of any kind should therefore be determined by the cost of its nitrogen. * * *

The results of the tests bear directly upon a question of great practical importance, that of exchanging cotton seed for cotton-seed meal. Many mills offer 700 pounds of meal, and some 1,000 pounds in exchange for 2,000 pounds of seed. Would such exchange be judicious? * * * It appears that as far as these tests go 560 pounds of cotton-seed meal are fully equal in fertilizing value to 1,560 pounds of cotton seed, a proportion of 1 to 2.79. In the oil mills a ton, or 2,000 pounds, of seed gives about 700 pounds of meal, besides oil and some waste product. Now 700 pounds is in proportion to 2,000 pounds as 1, to 2.85. This close correspondence of fertilizing value to output is certainly remarkable.

[Phosphoric acid.] The averages of the three farms for the 2 years show a slight difference in favor of the acid phosphate. The reduced phosphate (containing available phosphoric acid) appears to stand next. The two basic phosphates—Thomas slag and floats—gave about the same average. It appears also that in every case the half amount of phosphoric acid gave nearly as good returns as the full amount. The true results, however, were undoubtedly masked by the dry season of 1888, which prevented the action of the fertilizers at all three farms, and by their failure upon the thin, sandy soil of the Columbia farm both in 1888 and 1889. It is very probable that in favorable years the acid phosphate would show its superiority, for the results thus far reached are in favor of the soluble form.

[Potash.] (1) It is doubtful whether potash was of any real benefit to the crop. (2) It is certain that the full theoretical amount deduced from the analysis of the plant was excessive, and that half this amount was abundantly sufficient (perhaps

more than sufficient) for the needs of the crop and soil. (3) Of the three potassic manures tested, one kind was about as effective as another (when equivalent amounts were applied). Hence the employment of any one of the three is simply a question of its cost.

(3) *Modes of applying fertilizers for corn.*—A comparison of fertilizers applied broadcast and in drills on the same plan as that followed in 1888. The indications were the same as in the preceding year, *i. e.* "the two methods of applying manures gave practically the same average returns."

(4) *Modes of planting corn.*—A 2-years' trial of planting in drills and hills (checking), according to the plan detailed in the first year's report, seemed to show "that one method of planting gave about as good results as the other, and that it made little difference whether the rows were 5 or 6 feet apart, or the checks 5 feet by 3 feet or 6 feet by 3 feet."

(5) *Modes of cultivating corn.*—As in 1888, this was a test of "(1) the advantages of subsoiling the seed furrow before planting; (2) the comparative effects of deep and shallow cultivation; and (3) the value of thorough cultivation." As between the different methods the results for the 2 years showed "surprisingly little difference. * * * It appears that subsoiling the seed furrow did not improve the crop, and that deep culture and imperfect tillage did not materially affect it. It should be explained, however, that our 'ordinary cultivation,' that is the cultivation given to all the other plats, was much more thorough than the tillage given on the average farm." It is believed that the advantages of thorough cultivation would have been more apparent on heavy soils than on the light soils used.

(6) *Varieties of corn.*—Tests at the Columbia farm of 9 varieties of corn.

(7) *Rotations for corn.*—Tabulated data on the yields in 1889 of the series of rotations for corn commenced in 1888. "Up to this time protective and green crops [oats and peas] grown along with the corn have not materially affected the yield one way or another."

Experiments with cotton (pp. 268–342).—"The experiments with cotton may be classified as follows: Tests of varieties, fertilizers in general, nitrogenous manures, phosphatic manures, potassic manures, composts, methods of applying manures, time for applying nitrate of soda, modes of planting, topping, and rotations. * * * Amounts of potash, phosphoric acid, and nitrogen found by analysis in a crop yielding 300 pounds of lint per acre were applied, except where otherwise mentioned. These are called the full amounts or doses."

The season of 1889 is said to have been very unfavorable for cotton in many parts of the State.

(1) *Tests of varieties.*—The results are given of tests of 15 varieties of cotton at Spartanburg, 47 at Columbia, and 18 at Darlington in 1889; the averages of 8 varieties tested at all three farms for 2 years; and the averages for varieties tested for several years at the Columbia farm

as follows: 41 varieties for 2 years, 37 for 3 years, 25 for 4 years, 13 for 6 years, and 7 for 7 years.

"The old Rio Grande (under the names of Texas Wood, Peterkin, Crosland, etc.) is certainly entitled, from the results of our numerous tests, to the position of honor."

(2) *Fertilizers on cotton.*—The tests commenced in 1888 at each of the three farms were continued without change in 1889. Although the crop of 1889 was in general unsatisfactory, the indications of the 2-years' trial were that—

Marl and copperas produced no effect upon the crop; separate applications of potash, phosphoric acid, and nitrogen were equally valueless; their combinations produced marked effects; phosphoric acid and nitrogen played the most important parts; potash was of relatively less value than the other two; excessive applications of one or all three gave no adequate returns; the proportions indicated by analysis were not the correct ones; probably one half potash, one phosphoric acid, and one half nitrogen would be nearer approximations to the requirements of the plant. There is reason to believe, however, that the potash might be reduced to one third, and the phosphoric acid and nitrogen, respectively, increased to one and one half and two thirds with advantage.

(3) *Special nitrogen, phosphoric acid, and potash experiments.*—These experiments were in all respects similar to the corresponding series with corn mentioned above, and were in continuation of experiments in 1888. The data are fully tabulated for each farm, together with the averages for the 2 years. The following summary of the results is by the author:

[Nitrogen.] (1) Stable manure gave the best average for the 2 years at each of the three farms. The double dose [12 tons per acre] increased the crop, as compared with the full dose, by from 75 to 100 pounds lint per acre. At Spartanburg and Darlington the mixture of stable manure and nitrate of soda gave as good results as the equivalent amount of stable manure, and as good a combined average for the three farms.

(2) The differences between the combined averages of the other kinds (nitrate of soda, dried blood, cotton-seed meal, and cotton seed whole or ground) were comparatively slight. The dried blood gave rather the best average.

(3) Heavy doses of nitrogen were not required by cotton. In nearly every case the half dose gave as good results as the full.

(4) The point of most importance to our farmers is the remarkably close agreement in the combined averages of cotton-seed meal, whole cotton seed, and ground cotton seed. * * * Seven hundred and forty-five pounds of the cotton seed meal were fully equal in fertilizing value to 2,080 pounds of cotton seed (whether whole or ground), that is to say, 1 pound of the meal was equal to 2.79 pounds of seed [the same proportion as was found in the corn experiments].

[Phosphoric acid.] The superiority of the acid phosphate is clearly shown throughout. Its average for the 2 years at each farm largely exceeded those of the other three kinds. Reduced phosphate gave the next best averages. The slag and floats gave very nearly the same returns. The half doses proved inferior to the full.

[Potash.] The agreement in the average results of both the full and half doses of the three potassic manures is remarkably close. They abundantly confirm those of the similar tests with corn. One source of potash is as good as another and the farmer's choice must be determined by the price of the potash in each and the freight charges. As a general rule kainit would be preferred for the above reasons.

(4) *Composts on cotton.*—This is a trial at the Columbia farm of the eight composts tested in 1888. All of the composts gave as good results as the complete fertilizer supplying the theoretical amounts of ingredients.

(5) *Modes of applying fertilizers for cotton.*—These experiments were to compare the effects of applying fertilizers broadcast and in the hill. As in the previous year, fertilizers containing the full and one half the theoretical amounts of ingredients were applied broadcast and in the hill, the same amount per acre being used in either case.

"From all the results of the above tests it would appear to follow that where heavy amounts of fertilizers are used one mode of application answers just as well as the other, but that moderate amounts can be applied more effectively in the drill. When applied by hand the cost of each method is the same."

(6) *Time for applying nitrate of soda.*—Experiments were begun in 1889 at the Columbia and Darlington farms to secure data as to the best time for applying nitrate of soda—whether at time of planting or in top-dressings during the growing season. Using the full theoretical amounts of nitrogen (as nitrate of soda), phosphoric acid, and potash in all cases, the nitrogen was applied in one case half at time of planting and half later, and in another case in two top dressings about 3 weeks apart. The land selected at Darlington proved so uneven "as to vitiate the results." The results at Columbia indicated "a slight difference in favor of applying all the nitrate of soda in top-dressings upon the growing crops."

(7) *Different proportions of nitrogen, phosphoric acid, and potash for cotton.*—The results are tabulated for experiments made in 1889 at the Columbia and Darlington farms with a view to ascertaining the proportion of nitrogen, phosphoric acid, and potash required by the cotton crop. The season was so unfavorable at Columbia and the land so uneven at Darlington that the results furnished no reliable indications.

(8) *Modes of planting cotton.*—A continuation of the comparison of checking and drilling commenced in 1888. Tables show the average results of twelve tests, two at each of the three farms for 2 years. "The close agreement in the returns of the checked and drilled plats is remarkable. It appears that either mode of planting may be indifferently employed, and that the distance within the limits tested matters little. Our tests, however, cover a period of only 2 years, one of which was very unfavorable for cotton."

(9) *Topping cotton.*—Tests at two farms in 1888 and 1889, in which the cotton on one plat was topped and that on another was not topped, indicated that "topping produced no beneficial effects and involved an unnecessary outlay."

(10) *Rotations of cotton.*—Tabulated data are given on the yields of cotton in 1889 under each of the eleven systems inaugurated the year

previous. While "it is of course too early as yet to expect results," attention is called to the following points:

(1) Thus far peas along with the cotton, oats sowed among the cotton plants in the fall and turned under in the spring, and the return of the [cotton] seed of the preceding year alone or in connection with the pea or oat crop, have been of but slight benefit to the cotton.

(2) The difference between the effects of peas and oats is slight.

(3) As remarked under the head of the rotations for corn, the pea and oat crops were certainly grown without injury to the cotton crop of the same year.

Miscellaneous crops (pp. 342–344).—This includes brief remarks on tobacco, sorghum, sugar cane, and soja beans raised at the station, and a statement of the yields and in some cases of the estimated financial results.

REPORT OF TREASURER, I. H. MEANS (p. 345).—An exhibit of the receipts and expenditures of the station for the fiscal year ending June 30, 1889.

Tennessee Station, Bulletin Vol. IV, No. 3, July, 1891 (pp. 22).

THE HETEROPTERA OF TENNESSEE, H. E. SUMMERS (pp. 75–96, plate 1, figs. 12).—This includes an illustrated account of the terms used in describing insects, a key to the families of *Heteroptera*, and classified accounts of insects of this order which are found in Tennessee, together with suggestions as to remedies for these insects, and a description of spraying apparatus.

Texas Station, Bulletin No. 17, August, 1891 (pp. 16).

GENERAL INFORMATION REGARDING THE STATION, G. W. CURTIS, M. S. A. (pp. 109–122).—The acts of Congress and of the State legislature under which the station was established, a brief account of the organization of the station, with lists of officers, a summary of the results of experiments, an outline of the work in progress, an inventory of station property, and a financial statement for each year during which the station has been in operation.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 89 (NEW SERIES), OCTOBER, 1891 (pp. 521–590).—This includes articles on the yield per acre of wheat, rye, barley, and oats; the condition of corn, potatoes, buckwheat, and tobacco October 1; the crop of flaxseed in 1891; the wine industry of Napa County, California; foreign tariffs on agricultural products; tariffs under reciprocity treaties; agriculture in Bolivia and Japan: European crop report for October; and transportation rates for October.

Flaxseed.—A special investigation, undertaken for the purpose of ascertaining the production of flaxseed this year, shows that there has been a large increase in the area devoted to this crop during the last 2 years, the increment being entirely west of the Mississippi River, and confined mainly to the States of Minnesota, Iowa, Kansas, Nebraska, and the Dakotas. The acreage for 1891 is estimated at 1,927,293 acres, and the product of seed 15,455,272 bushels. The season was mainly favorable and the average yield large. * * *

The enlargement is in those districts having the larger proportion of new lands. * * * Flax has been found the best crop for first cultivation on sod land, assisting in getting the soil into good tilth for other crops, besides being a money crop. * * * Another potent reason, however, for the heavy enlargement during the past 2 years is the fact that there has been a steady demand for flaxseed at prices which have paid for its cultivation better than the returns from wheat growing. * * * An increased acreage based upon such reasons can not be permanent, and already, with lower offerings on the farm for the seed, there are indications that some portion of the area will be abandoned next year.

Under present conditions the crop is grown almost entirely for seed, the fiber not being made use of to any great extent. * * * As many correspondents declare, flax growing for the seed alone does not pay except as a first crop. The future of the industry depends upon the utilization of the fiber as well as of the seed. There are indications in some sections of the Northwest, especially in Minnesota, of popular interest in the question of establishing a fiber industry; and in fact this interest has been a factor in the increase in the area given to flax in that State.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. IV, NOS. 1 AND 2, OCTOBER, 1891 (pp. 86, fig. 1).—This double number consists for the most part of the proceedings of the Association of Economic Entomologists held at Washington,

D. C., August 17 and 18, 1891. The President's inaugural address was delivered by J. Fletcher of Canada. The following papers were read: Destructive Locusts of North America, together with Notes on the Occurrences in 1891, by L. Bruner of Nebraska; *Chilo saccharalis* in New Mexico, The White Grub of *Allorhina*, and Miscellaneous Notes, by C. H. T. Townsend of New Mexico; Notes on Blackberry Borers and Gall Makers, and The Squash Borer (*Melittia cucurbitæ*) and Remedies therefor, by J. B. Smith of New Jersey; Notes on the Cotton Cutworm (*Agrotis annexa*), and A Nematode Leaf Disease (*Aphelenchus* sp.), by G. F. Atkinson of Alabama; Kerosene Emulsion and Pyrethrum, by C. V. Riley of the U. S. Department of Agriculture; Work of the Season in Mississippi, by H. E. Weed of Mississippi; Note on the Horn Fly (*Hæmatobia serrata*) in Ohio, by D. S. Kellicott, of Ohio; Notes of the Season, by E. A. Ormerod of England; Notes on the Recent Outbreak of *Dissosteira longipennis*, by E. A. Popenoe of Kansas; Notes on a Corn Crambid (*Crambus caliginosellus*), by M. H. Beckwith of Delaware; Notes of the Year in New Jersey, by J. B. Smith of New Jersey; Government Work and the Patent Office, by C. V. Riley of the U. S. Department of Agriculture; A Note on Parasites, by L. O. Howard of the U. S. Department of Agriculture; Report of a Trip to Kansas to Investigate Reported Damages from Grasshoppers, by H. Osborn, of Iowa; The Clover Seed Caterpillar (*Grapholitha interstinctana*, Clem.), by H. Osborn and H. A. Gossard of Iowa; Standard Fittings for Spraying Machinery, by W. B. Alwood of Virginia; Entomological Work in Central Park, by E. B. Southwick of New York; Some Historic Notes, by A. J. Cook of Michigan; An Experiment with Kerosene Emulsions, by H. Osborn of Iowa; A Note on Silk Culture, by P. Wallace of California; Notes on a few Borers, by G. C. Davis of Michigan; The Poplar Gonioctena (*Gonioctena pallida*, Linn.), by A. J. Cook of Michigan; Notes of the Season from South Dakota, by J. M. Aldrich of South Dakota; A Note on Remedies for the Horn Fly, by W. B. Alwood of Virginia; The Chinch Bug Disease and other Notes, by F. H. Snow of Kansas.

DIVISION OF VEGETABLE PATHOLOGY.

JOURNAL OF MYCOLOGY, VOL. VII, NO. 1, SEPTEMBER 10, 1891 (pp. 63, plates 10).—This number includes articles on Sweet Potato Black Rot (*Ceratocystis fimbriata*, E. and Hals.), by B. D. Halsted and D. G. Fairchild; Experiments in the Treatment of Plant Diseases, part III, by B. T. Galloway; Diseases of the Orange in Florida, by L. M. Underwood; Peach Blight (*Monilia fructigena*, Persoon), by E. F. Smith; the improved Japy Knapsack Sprayer, by B. T. Galloway; Notes on some Uredineæ of the United States, by P. Dietel; New Species of Uredineæ (*Puccinia hemizoniæ*, *Æcidium oldenlandianum*, and *Æ. malvastri*), by J. B. Ellis and S. M. Tracy; A New Pine Leaf Rust (*Coleosporium pini*), by B. T. Galloway; Observations on New Species of Fungi

from North and South America—*Puccinia heterogenea, Uredo gossypii, Doassansia gossypii, Peronospora gonolobi*; Reviews of Recent Literature—*Untersuchungen aus dem Gesammtgebiete der Mykologie, Heft* IX, Münster (Dr. Oscar Brefeld); *Crittogamia Agraria*, Naples (Dr. O. Comes); *Der falsche Mehltau, sein Wesen und seine Bekämpfung*, Zurich (J. Morgenthaler); Index to North American Mycological Literature (continued), by D. G. Fairchild.

OFFICE OF IRRIGATION INQUIRY.

PROGRESS REPORT ON IRRIGATION IN THE UNITED STATES (pp. 337, plates 5).—This includes articles on Irrigation in the United States, by R. J. Hinton; Artesian and Underflow Investigation, by R. Hay and by J. W. Gregory; Progress of Irrigation in Montana, Idaho, eastern Washington, and Oregon in 1890, by J. W. Nimmo, jr.; Irrigation Statistics and Progress in Colorado for 1890, by L. G. Carpenter; Artesian Water in Nevada, by C. W. Irish; Phreatic Waters in Nye County, Nevada, by G. Nichols; Imbibition of Rocks, by R. T. Hill; The Cultivation of the Raisin Grape of California by Irrigation, condensed from a recent publication by G. Eisen; Irrigation in Australia, by R. J. Hinton; and Alkali Soils and Waters in California, condensed from reports by E. W. Hilgard. A large amount of information is given regarding the history, present condition, methods, and legal relations of irrigation in the United States.

Lands under ditch in the arid and semiarid region.

States.	Under ditch. 1889.	Under ditch. 1890.	Under cultivation, 1890.
	Acres.	*Acres.*	*Acres.*
Arizona*	529,200	643,150	310,100
California	3,294,000	4,044,000	2,444,000
Colorado	2,813,273	1,004,009	1,585,000
Idaho	715,500	1,181,500	327,000
Kansas (western)	500,000	800,010	100,000
Montana	980,000	1,100,000	400,000
Nebraska (western)	50,000	65,000	10,000
Nevada	142,000	150,000	75,000
New Mexico	638,455	677,315	450,000
Oregon (eastern)	75,000	100,000	45,000
South Dakota (Black Hills)	100,000	100,000	20,000
Elsewhere in the Dakotas	....	2,000	2,000
Texas	200,000	340,000	160,000
Utah	700,000	700,000	413,000
Wyoming	1,946,876	1,946,876	175,000
Wyoming (eastern)	75,000	150,000	60,000
Total	12,764,304	16,004,160	7,576,100

* In Arizona for 1890 two estimates were sent in, one of 587,460 acres under ditch and 205,200 cultivated acres, by the Acting Governor; the other, 699,440 acres under ditch and 325,000 cultivated, by Government officers. The figures above are the mean of the two estimates.

It may safely be assumed that there are very many small irrigated areas scattered throughout the arid region which are not included in these estimates. There are also larger areas, not many in number, perhaps, in which the use of water for irrigating natural and cultivated grasses is of considerable importance. No estimate is

attempted of the small irrigations of house gardens, lawns, and fruit trees which prevail in every city, town, and village west of the ninety-seventh meridian. Altogether it will not be unreasonable to suppose that the area actually cultivated in 1890 reaches at least 8,000,000 acres.

Estimated areas of arid lands reclaimable by irrigation.

Political divisions.	Reclaimable by irrigation.	Political divisions.	Reclaimable by irrigation.
	Acres.		*Acres.*
California	25,000,000	Wyoming	12,000,000
Colorado	20,000,000	Public land strip	2,000,000
Dakotas, North and South	33,000,000	Texas, west of 97°	20,000,000
Nevada	7,000,000	Oregon and Washington, east of Cascade Range	20,000,000
Arizona	12,000,000	Kansas, Nebraska, Oklahoma, and Indian Territory, west of 97°	30,000,000
Montana	30,000,000		
Idaho	10,000,000		
New Mexico	11,000,000		
Utah	10,000,000	Total	245,000,000

ARTESIAN AND UNDERFLOW INVESTIGATION IN NEBRASKA AND KANSAS, E. S. NETTLETON (pp. 14, maps and tables 12).—A report on investigations in November and December, 1890, in the valleys of the Platte and Arkansas Rivers. The author states that in Kansas and Nebraska—

The necessity for irrigation is growing less and the line separating the humid from the semiarid regions is moving westward. This movement is, however, growing slower and slower with each degree covered, and the point where it will stop will somewhere be reached. * * * The difference in the final outcome of irrigation development in Kansas and Nebraska and that in Colorado will be that irrigation in Kansas and Nebraska will be confined to disconnected and smaller irrigation districts and the more general utilization of the underground waters, and doubtless a much smaller percentage of land cultivated by aid of irrigation.

The various methods of irrigation available to a greater or less extent for this region are as follows:

(1) The use of subterranean water obtained by open subflow ditches.

(2) The use of subterranean waters raised a few feet by mechanical means.

(3) The use of subterranean waters raised from the ordinary farm wells by windmills.

(4) The use of the small perennial flow of the streams on the plains.

(5) The storage and immediate use of storm waters.

(6) The use of the flow of artesian wells.

WEATHER BUREAU.

SPECIAL REPORT FOR 1891, M. W. HARRINGTON (pp. 26).—This includes general statements regarding the reorganization of the Bureau after its transfer to this Department July 1, 1891, and accounts of the operations of the different branches of the Bureau. "Local forecast officials" have been appointed at the larger cities, who are to study especially the climatology and topography of their respective sections, as well as the relation of the weather to the growth of crops. These observers are permitted to predict the weather for more than 1 day

in advance. The number of places where weather maps are issued has been increased to over 60 and the distribution of the maps has been enlarged, especially in agricultural communities. The cotton region reports are now sent to the State weather service headquarters, as well as to the Weather Bureau centers, and telegraphic information of the first killing frost at every cotton region station will hereafter be included in these reports. A similar service is contemplated for the sugar region. An exhibition showing the working of a Weather Bureau station was recently made at a fair at Albany, New York, and it is intended to make these displays at other places. The method of preparing and distributing the weather forecast is described in outline. States and Territorial weather services have been organized since July 1 in 11 States and Territories, making 39 such services now in operation. More than 100 new voluntary meteorological stations have been established. The number of weather signal display stations has been increased from 630 to over 1,200. An index of meteorological observations in the United States is being prepared for distribution to the principal stations of the Bureau with a view to giving greater publicity to the data in the records of the office. There are at present about 2,200 voluntary observers in the United States, an increase of about 400 in 3 months. A liberal policy in providing these observers with instruments and information is recommended. An index to foreign meteorological observations is being prepared. Other topics treated in the report are the Pacific Coast division of the Bureau, river and flood service, telegraph service, the instrument room, monthly weather review, bibliography of meteorology, international conference of meteorologists, and the relations of the Bureau to the agricultural colleges and experiment stations.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

Experiments on root tubercles and the fixation of atmospheric nitrogen, J. B. Lawes and J. H. Gilbert.—[As stated in the account of the meeting of the section for agricultural chemistry of the German Association for the advancement of science (*Abtheilung für Agrikulturchemie und landwirthschaftliches Versuchswesen der Gesellschaft deutscher Naturforscher und Aerzte*) at Halle, in the Experiment Station Record, vol. III, p. 207, a paper was presented by Prof. J. H. Gilbert, LL. D., F. R. S., on the results of experiments at Rothamsted on the fixation of free nitrogen by plants, with special reference to the occurrence and functions of root tubercles. The following abstract of his paper has been furnished by Professor Gilbert:]

From the results of the experiments of Boussingault and also of those made at Rothamsted under conditions of sterilization and inclosure more than 30 years ago, Sir J. B. Lawes and J. H. Gilbert had always concluded that at any rate our agricultural plants did not assimilate free nitrogen. They had also abundant evidence that the Papilionaceæ as well as other plants derived much nitrogen from the combined nitrogen in the soil and subsoil. Still they had long recognized that the source of the whole of the nitrogen of the Papilionaceæ was not explained, that there was in fact "a missing link." They were therefore prepared to recognize the importance of the results regarding the root tubercles and their connection with the assimilation of nitrogen by legumes,* first announced by Professor Hellriegel in 1886, and they had hoped to commence experiments on the subject in 1887, but they had not been able to do so until 1888. These first results showed a considerable formation of nodules on the roots, and, coincidently, great gain of nitrogen in plants grown in sand (with the plant ash) when it was microbe-seeded with a turbid watery extract of a rich soil.

In 1889 and since they made a more extended series of experiments. The plants were grown in pots in a glass house. There were four pots of each description of plant, one with sterilized sand and the plant

*A brief review of the history of investigations in this line was given by Professor Gilbert, but was not deemed by him essential for this abstract, which is intended to present only the general plan and results of the last Rothamsted investigations, with a few typical illustrations selected from a large number of experiments. For a review of this subject see Experiment Station Record, vol. II, p. 686, and vol. III, p. 56.

ash; two with the same sand and ash, but microbe-seeded with watery extract for some plants from a rich garden soil, for lupines from a sandy soil in which lupines were growing luxuriantly, and for some other plants from soil where the particular plant was growing. In all, in 1889 and subsequently, they had grown in this way four descriptions of annual plants, namely, peas, beans, vetches, and yellow lupines, and four descriptions of longer-lived plants, namely, white clover, red clover, sainfoin, and lucern. Without microbe-seeding there was neither nodule formation nor any gain of nitrogen; but with microbe-seeding there was nodule formation, and, coincidently, considerable gain of nitrogen.

However, as in this exact quantitative series the plants were not taken up until they were nearly ripe, it is obvious that the roots and their nodules could not be examined during growth, but only at the conclusion, when it was to be supposed that the contents of the nodules would be to a great extent exhausted. Another series was therefore undertaken in which the same four annuals and the same four plants of longer life were grown in specially made pots, so arranged that some of the plants of each description could be taken up and their roots and nodules studied at successive periods of growth; the annuals at three periods, (1) when active vegetation was well established, (2) when it was supposed that the point of maximum accumulation had been approximately reached, and (3) when nearly ripe; and the plants of longer life at four periods, (1) at the end of the first year; (2) in the second year, when active vegetation was reëstablished; (3) when the point of maximum accumulation had been reached; and (4) when the seed was nearly ripe. Each of the eight descriptions of plants was grown in sand (with the plant ash) watered with the extract from a rich soil; also in a mixture of two parts of rich garden soil and one part of sand. In the sand the infection was comparatively local and limited, but some of the nodules developed to a great size on the roots of the weak plants so grown. In the rich soil the infection was much more general over the whole area of the roots; the nodules were much more numerous, but generally very much smaller. Eventually the nodules were picked off the roots, counted, weighed, and the dry substance and the nitrogen in them determined.

Taking the peas as typical of the annuals and the sainfoin of the plants of longer life, the general result was that at the third period of growth of the peas in sand the amount of dry matter of the nodules was very much diminished, the percentage of nitrogen in the dry matter was very much reduced, and the actual quantity of nitrogen remaining in the total nodules was also very much reduced, in fact the nitrogen of the nodules was almost exhausted. The peas grown in rich soil, however, maintained much more vegetative activity at the conclusion, and showed a very great increase in the number of nodules from the first to the third period, and with this there was also much more dry substance and even a greater actual quantity of nitrogen in the total

nodules at the conclusion. Still, as in the peas grown in sand, the percentage of nitrogen in the dry substance of the nodules was very much reduced at the conclusion. In the case of the plant of longer life—the sainfoin—there was, both in sand and in soil, very great increase in the number of nodules and also in the actual amount of dry substance and of nitrogen in them as the growth progressed. The percentage of nitrogen in the dry substance of the nodules also showed, even in the sand, comparatively little reduction, and in soil even an increase. In fact, separate analyses of nodules of different character or in different conditions showed that while some were more or less exhausted and contained a low percentage of nitrogen, others contained a high percentage and were doubtless new and active. Thus the results pointed to the interesting conclusion that although with the plant of longer life the earlier-formed nodules became exhausted, others were constantly produced to provide for future growth.

As to the explanation of the fixation of free nitrogen, the facts at command did not favor the conclusion that under the influence of the symbiosis the higher plant itself was enabled to fix the free nitrogen of the air by its leaves; nor did the evidence point to the conclusion that the nodule bacteria became distributed through the soil and there fixed free nitrogen, the compounds of nitrogen so produced being taken up by the higher plant. It seemed more consistent, both with experimental results and with general ideas, to suppose that the nodule bacteria fixed free nitrogen within the plant, and that the higher plant absorbed the nitrogenous compounds produced. In other words, there was no evidence that the chlorophyllous plant itself fixed free nitrogen, or that the fixation takes place within the soil, but it was more probable that the lower organisms fix the free nitrogen. If this should eventually be established we have to recognize a new power of living organisms—that of assimilating an elementary substance. But this would only be an extension of the fact that lower organisms are capable of performing assimilation work which the higher can not accomplish, while it would be a further instance of lower organisms serving the higher. Finally it may here be observed that Loew has suggested that the vegetable cell with its active protoplasm, if in an alkaline condition, might fix free nitrogen, with the formation of ammonium nitrate. Without passing any judgment on this point, it may be stated that it has frequently been found at Rothamsted that the contents of the nodules have a weak alkaline reaction when in apparently an active condition, that is while still flesh-red and glistening.

As to the importance of the fixation for agriculture and for vegetation generally, there is also much yet to learn. It is obvious that different Papilionaceæ, growing under the same external conditions, manifest very different susceptibility to or power to take advantage of the symbiosis, and under its influence may gain much nitrogen. This is of interest from a scientific point of view as serving to explain the source of

some of the combined nitrogen accumulated through ages on the surface of the globe; and also from a practical point of view, since, especially in tropical countries, such plants yield many important food materials, as well as other industrial products.

Root tubercles and acquisition of nitrogen by legumes—inoculation experiments in field culture, Hellriegel and Wilfarth.—In the account given in the present volume of the Experiment Station Record, p. 207, of the meetings of the section for agricultural chemistry of the German Association for the advancement of science at Halle, in September, 1891, mention was made of a somewhat informal report by Professor Hellriegel, director of the experiment station at Bernburg, on the continuation of his investigations upon root tubercles and the fixation of atmospheric nitrogen by plants.

It will be remembered that the experiments of Professor Hellriegel have been made mostly by the method of sand culture, which he has developed by many years of experimental inquiry, and that although the acquisition of large quantities of atmospheric nitrogen by leguminous plants had been demonstrated before Hellriegel's work at Bernburg on this subject was undertaken, yet it was through those investigations that the connection between root tubercles, bacteria, and the fixation of nitrogen was first found out. Few discoveries in biological and agricultural chemistry have brought or promise to bring such an important train of results as this. The development of the subject by various experiments has been recorded from time to time in the Record (vols. I, p. 194; II, p. 686, and III, pp. 56, 116). Through the courtesy of Professor Hellriegel and of Dr. Wilfarth, who has been associated with him in these investigations, the following résumé of their latest results, preceded by a brief recapitulation of the earlier work at Bernburg, has been furnished by the latter gentleman for publication in the Record:

Previous investigations had shown that while the leguminous plants can avail themselves of the free nitrogen of the air, they can do this only when certain kinds of bacteria have entered them and caused the production of the root tubercles characteristic of the legumes. Leguminous plants which are cultivated in sterilized media and kept free from bacteria during their growth, so as to prevent this symbiosis, and which in consequence have no tubercles, do not acquire nitrogen from the air. Thus cultivated they behave like the non-leguminous plants, which, as experiments have repeatedly shown, can not assimilate free nitrogen.

During the last few years a series of experiments has been going on at Bernburg with legumes which have been kept under conditions of sterility. These experiments have brought out the fact that the legumes thus kept sterile not only failed to fix nitrogen, as just stated, but also when they were well supplied with other food and deprived of nitrogen compounds in the medium in which they grew, remained in a starved condition, though they grew well when nitrogen compounds were supplied.

The later experiments have shown still further that the sterilized legumes develop exactly in proportion to the amount of nitrogen furnished in the soil and that if enough nitrogen is thus supplied the plants grow luxuriantly and show a perfectly normal development of seeds. Of course a very abundant supply of nitrogen is necessary. The experiments have shown that it must be applied in a form best suited to the plants. It was found that ammonium nitrate is the most appropriate form for supplying leguminous plants with nitrogen. Other compounds, such as calcium nitrate, do not agree so well with them. Lupines fed with the latter compound become sickly and their development is imperfect.

The statements just made refer to plants cultivated in pure sand by Hellriegel's method. By this method healthy plants and especially a normal development of seeds, can be obtained. This is illustrated by trials with lupine plants in two pots of equal size, one containing natural soil with bacteria, the other sterilized sand. Two plants were grown in each pot. The weights of the plants produced (stems, leaves, and fruit, but not the roots) were, (1) in a natural soil with symbiosis, 41.08 grams of dry substance, of which the seeds were 25.7 per cent; (2) in sterilized sand with ammonium nitrate, 40.79 grams of dry substance, of which 26.7 per cent were seeds.

A number of experiments were made in pots with natural soil. Whenever the soil was not sterilized the leguminous plants had tubercles on the roots and a notable acquisition of nitrogen was found. When they were kept sterile the plants grew only in proportion to the nitrogen contained in the soil, but when nitrogenous fertilizing material was added to the sterilized cultures, the amount of plant growth increased in proportion to the amount of nitrogen supplied. The roots had no tubercles and there was no evidence of acquisition of atmospheric nitrogen. In this way the same principle is found to apply to culture in soil containing humus, as in pure sand. The view of Frank, who claims especial effects in humus soils, is thus refuted.

Besides these pot experiments a series of field trials were made with lupine and serradella to study the effects of inoculating with bacteria.

The experiments at Bernburg bring out the fact (which has been confirmed by other observations, *e. g.*, those of Nobbe, described in the present number of the Record, page 336) that different leguminous plants do not avail themselves of the same kind of bacteria, but rather that a given species may require a special form for the symbiosis by which the free nitrogen is fixed. Thus, for instance, the root tubercle bacteria of peas do not produce tubercles in lupines and serradella, and therefore do not enable them to acquire nitrogen from the air. Now these different forms of bacteria are not found in all arable soils. Thus the cultivated soils in the vicinity of Bernburg contain an abundance of pea bacteria, but none or very few of the lupine bacteria, because lupines have never been cultivated in this region. On the other hand,

in regions where the cultivation of these plants has been carried on for many years the soil is full of lupine bacteria.

In such a region a quantity of surface soil was procured from a field where lupines had been raised, carried to Bernburg, and used for inoculation in the field trials. For these latter a number of narrow strips of the experimental fields of the station were planted with yellow, blue, and white lupines. On some of these strips the lupine soil was applied in different quantities and plowed under to different depths, while other strips received none of the lupine soil. The quantities of inoculating soil used on the different strips were 10, 25, 50, 100, and 200 *Centner* per hectare, or from 446 to 8,925 pounds avoirdupois per acre. Similar experiments were made with serradella.

The field was in pretty fair condition as to manuring, so that even the plants which were not inoculated could develop tolerably well by feeding on the nitrogen of the soil. Nevertheless the effect of the inoculation was plainly manifest on all the strips. At the time of blooming all plants which had been treated with lupine soil were easily distinguishable to the eye, even at a distance, by their greener color and better development. The differences in the plants with the different quantities of inoculating soil were likewise plainly visible, the effect increasing with the amount applied; indeed with the largest quantity the effect was excessive, so that in some places the plants lodged. The inoculation was equivalent in effect to the addition of nitrogenous manure.

In order to compare the plants, and especially the roots, pieces 1 square meter in size were dug out of the different strips. Here again the effect of the inoculating soil was plain. In strips without inoculation there were some plants, especially among the yellow lupines, which had root tubercles, but the tubercles were generally on the branch roots and not very well developed. The inoculated plants, however, had large, healthy tubercles on the main roots, and the number of tubercles increased with the increase in the quantity of soil used for inoculation. Upon the strips which had not been inoculated from 99 to 100 per cent of the plants of the blue and white lupines were found to be without tubercles, while on the inoculated strips from 74 to 100 per cent had tubercles, the number varying with the amount of inoculating soil. There is no doubt that when the quantitative yields of the plants are determined they will show notable increase with the inoculation.

These experiments of the last few years, taken altogether, completely confirm the propositions set forth as the result of the earlier investigations by the station.—[W. O. A.]

Experiments in the assimilation of nitrogen by leguminous plants, F. Nobbe, E. Schmid, L. Hiltner, and E. Hotter (*Landw. Vers. Stat.*, *39*, *pp. 327–359*).—The experiments here reported were carried out during 1890 at the experiment station at Tharand, Saxony.

At the time the experiments were planned the investigations of Prazmowski had not been made public. The plants used were peas, yellow lupine, beans (*Phaseolus vulgaris*), common locust (*Robinia pseudacacia*), honey locust (*Gleditschia triacanthos*), and laburnum (*Cytisus Laburnum*), the object being (1) to test the fixation of nitrogen by certain papilionaceous trees; (2) to study the effects of using for the inoculation of the plants of the different genera, (*a*) extracts of soils in which each of the above-mentioned plants have been previously grown, and (*b*) pure cultures of bacteria prepared from soil infusions and from root tubercles; and (3) to determine whether the same form of bacteria is capable of causing the growth of tubercles on leguminous plants of different genera, or whether a special form exists for each kind of plant, with which alone they are capable of living in symbiosis.

The experiments were carried out in glass vessels of 6.5 liters capacity. Each vessel had three openings in the sides, just above the bottom. About a quart of pebbles was placed in the bottom of each jar, above this a layer of sterilized cotton batting, and then the soil, which was likewise covered with a layer of cotton. This artificial soil consisted of pure sterilized quartz sand, with 5 per cent by weight of peat* (previously treated to extract nitrogen). To this was added half a per cent of chemically pure calcium carbonate and a quantity of a nutritive solution. The materials were all sterilized before filling in the vessels, and each vessel and its contents were afterwards sterilized by heating to 95° C. on 3 separate days. Five plants were grown in each vessel.

The soil infusions were prepared by thoroughly shaking 60 grams of soil with 300 grams of water and filtering, and were used without delay. A bacteriological examination of the various infusions showed that those of different origin differed not only with regard to the total number of bacteria they contained, but also with regard to the proportion of colonies of the form designated by Beyerinck† as *Bacillus radicicola*. The averages of numerous determinations of the number of bacteria per c. c. in the infusions of different soils were as follows:

	Total number.	*Bacillus radicicola*
Pea soil infusion	1,980,000	78,000
Lupine soil infusion	156,000	None
Robinia soil infusion	880,000	78,000
Gleditschia soil infusion	340,000	40,000
Laburnum soil infusion	1,300,000	143,000

The lupine soil had been kept for several months before the infusions were made, and had become very dry. No *Bacillus radicicola* was found, and the bacteria present were all less active than those in the

* The peat proved unsatisfactory, as it decomposed, and in all experiments except the first series only half of the above amount was used.

† Bot. Ztg., 46 (1888).

infusions of the other soils. In preparing the pure cultures of bacteria from tubercles the tubercles were first washed with a weak solution of corrosive sublimate to destroy any germs on the surface, cut open with a sterilized knife, and a small amount of the tissue taken out with a platinum wire. At first only young tubercles were used, but later full-grown ones were employed with equally good results. In the inoculation the soil immediately surrounding each plant received 7 c. c. of the decoction.

First series of experiments.—In this series, peas, Robinia, laburnum, and Gleditschia were used. The plants of each genus were grown in sterilized soil, being inoculated in separate cases with soil infusions of lupine, peas, Gleditschia, Robinia, and laburnum soils, and with pure cultures of bacteria from pea and from Robinia tubercles, and in sterilized soil with a dressing of calcium nitrate or ammonium sulphate, or without the addition of nitrogen.

The results of this series of experiments show, as suggested by Hellriegel, that the extracts of different soils are quite different in their action on different leguminous plants, and the authors believe that these differences can not be accounted for, as Frank* suggested, by the difference in the number of bacteria present. In the case of Gleditschia, no symptoms of nitrogen starvation were noticed for over 2 months. The plants grew, although slowly, and produced on an average about four times as much dry matter as the original seeds contained, and in some cases a noticeable increase of nitrogen. No tubercles were formed on any of the roots, and no beneficial effects from the inoculation were perceptible.

The laburnum plants did not grow well in the soil mixture used and were harvested early. The indications were that plants of this genus respond slowly to inoculation.

The first pea plants to respond to the inoculation were those inoculated with pea extracts (either from soil or pure cultures), the change in the leaves being perceptible 20 days after the inoculation. The effects of Robinia soil extract were felt latest of all; the pure culture from Robinia tubercles met with an accident. In the case of both Robinia and peas nearly all the plants inoculated produced root tubercles and the tubercles were confined almost exclusively to those roots near the surface. The pea plants produced a much larger number than the Robinia. The roots of a single pea plant (inoculated with Gleditschia soil infusion) produced 4,572 normal tubercles.

The effects of the inoculation of Robinia were observed first where pure cultures from Robinia tubercles had been used (20 days after the inoculation) and 10 days later where Robinia soil infusion had been used. The effects where laburnum soil infusion was used were noticed about the same time, and where Gleditschia soil infusion was used about 10 days later, or 20 days after the Robinia soil infusion.

* Landw. Jahrb., 19 (1890), p. 618.

The infusions of lupine and pea soils and the pure cultures from pea tubercles showed no beneficial action up to the close of the experiment. It was found exceedingly difficult, although not altogether impossible, to cultivate Robinia in sterilized soil, under the precautions mentioned above, without the formation of tubercles. Plants inoculated after they had passed a certain stage, although they produced tubercles, failed to recover from the starvation period, and the author believes they were no longer capable of assimilating nitrogen even when the tubercles were present.

It was noticed where the inoculation of Robinia was successful that in general the amount of dry matter produced and the percentage of nitrogen in the same were larger than when the plants received a dressing of nitrogenous fertilizers instead. Thus, while the inoculated plants averaged 3.088 per cent of nitrogen, those manured with nitrogen averaged only 1.312 per cent.

The results of this series of experiments show, therefore, that in the case of peas and Robinia each kind of plants responded most readily to inoculation with extracts of soils in which a similar kind of plants had been previously grown, *i. e.* peas to pea soil extract, and Robinia to Robinia soil extract. On the other hand the Robinia soil extract when applied to pea plants was felt latest of all and the pea soil extract failed to produce any perceptible effect when applied to Robinia. The authors are forced to believe from these results that the infusions of different soils must contain bacteria which in some manner differ from each other. They believe, however, that the solution of the question must come through the study of pure cultures, as only indefinite results can be obtained with crude infusions.

While the pure cultures from Robinia tubercles were effective on Robinia plants, the pure cultures from pea tubercles, as well as the infusion of pea soil, were entirely without effect on Robinia. But the fact that the pure cultures from pea tubercles had almost no effect on pea plants rendered further trials necessary, although the authors suggest that the absence of action in the latter case may have been because the inoculation came too late for the rapidly growing pea plants.

Second series of experiments.—Peas, lupine, and beans were used, pure cultures being employed almost exclusively.

Pea plants were inoculated with pure cultures from the tubercles of peas, lupine, and Robinia, and from extracts of soils in which these plants had been grown. The plants inoculated with pure cultures from either pea soil or tubercles and from lupine tubercles produced root tubercles; the remainder failed to produce any tubercles. Those inoculated with bacteria from peas bore the tubercles on the roots of the second order; and those with cultures from lupine tubercles bore tubercles on the roots of the third order, and the tubercles were somewhat different in appearance from those where pea bacteria were used. These observations on the locality of the tubercles were verified in a second

experiment. The difference between the locality of the lupine and pea bacteria is believed to be due to a less energetic action of the lupine bacteria, and this theory is borne out by the growth of the plants in general. In repeated trials the pure cultures from Robinia soil or tubercles failed to produce any effect upon the peas. The authors believe that there can not be the slightest doubt that the pea and Robinia bacteria are different in their physiological action, and that if they do not represent different groups or varieties they at least represent separate modifications with regard to the process by which they derive their nourishment. Differences were also noticed in the growth of the colonies and the microscopical appearance of the bacteria from the two sources, the colonies of Robinia bacteria being somewhat lighter-colored than those of the pea bacteria, etc.

Lupine plants were treated with ammonium sulphate or inoculated with crude infusions of lupine soil (fresh sample) and laburnum tubercles, and with pure cultures of bacteria from lupine tubercles and soil, pea tubercles, Gleditschia soil, Robinia tubercles and soil, and laburnum tubercles. One vessel received no nitrogen or inoculation. The growth of the plants was weak in all cases. Only those plants which were inoculated with bacteria from lupines produced root tubercles, this result confirming in every way the results previously obtained with Robinia and peas. The observation made in the case of Robinia, that the tubercles were without action when formed so late that the leaves were no longer in a condition to assimilate and so recover from the starvation period, was confirmed in the case of lupine.

The object of the trial with beans (*Phaseolus vulgaris*) was to test the truth of the statement made by Frank,* that since the seeds themselves contain bacteria, beans are capable of forming tubercles, even when grown in sterilized soil, without inoculation. The plants were treated with calcium nitrate or inoculated with bean soil infusion and with pure cultures of bacteria from pea, lupine, and Robinia soils and tubercles. Two cultures remained sterile. Only those plants which were inoculated with bean soil infusion or with pure cultures of bacteria from pea soil or pea tubercles produced tubercles in any considerable number. This plant, then, presents no exception among the papilionaceous plants with respect to the formation of tubercles in sterilized soil. It was observed that where the plants were inoculated with bean soil extract or with pure cultures of pea tubercle bacteria, the root tubercles were on small roots of the third order. In most cases a root of the fourth order sprang from the tubercle, and this root often became much stronger than the root of the third order which bore the tubercle. It was also found that the roots springing from the tubercles were remarkable for the amount of crystals of oxalate of lime which they contained. The authors believe that the processes which lead to the increase of nitrogen in the plant take place in the tubercles, and that the

* Landw. Jahrb., 19 (1890).

materials in the roots of the fourth order which spring from the tubercles consist exclusively of metabolic products of the bacteria themselves. The question whether the bacteria take up and work over the free nitrogen of the air or water directly, or whether the crude nitrogen-containing materials are transmitted to them from the leaves, although the latter seems most probable to the authors, is not further discussed by them.

Other experiments.—In order that the conditions might be exactly the same for the different kinds of plants, peas, lupine, Robinia, laburnum, and Gleditschia were grown together in the same vessel. Four vessels, each containing one plant of each of the above species, were inoculated with pure cultures of bacteria from Gleditschia soil, and from pea, Robinia, and lupine tubercles, respectively; the plants in one glass remained sterile. All the plants in the same vessel were treated exactly alike. In the case of each vessel that plant did best which was inoculated with the bacteria peculiar to the tubercles of its own species. Thus, in the case of the inoculation with bacteria from pea tubercles, the pea plant far surpassed all the other plants in that glass in luxuriance of growth; where Robinia tubercle bacteria were used the Robinia did better than any other plant, etc.

The fact that in most cases the root tubercles occurred at a depth equivalent to only about one third of that to which the roots extended, seemed to indicate that the spontaneous diffusion of the bacteria in the soil takes place slowly. This would seem to explain the fact that there was no benefit from late inoculation. To test this point the following experiments were made: Six pea plants were placed in each of two sterilized vessels containing sterilized soil; one vessel contained no nitrogen and the other contained nitrogen in the form of calcium nitrate. One plant in each vessel was inoculated June 18 with 7 c. c. of extract of pea tubercles, directly on the upper portion of the root, by means of a pipette. At the time of the inoculation the plants in the nitrogen-free soil were just beginning to show signs of starvation. The inoculated plant began shortly to show unmistakable evidence of recovery. On the 28th of August the inoculated plant in the nitrogen-free soil was about twice as tall and contained nearly twice as many leaves as either of the other five plants. The effect of the inoculation in the vessel containing nitrogen, while less striking, was apparent. The indications are that the ability of these bacteria to diffuse in the soil spontaneously is quite limited. In this trial as well as in the first series of experiments, it was noticed that the pea plants which were developed by the aid of inoculation either produced no flowers, or in case they did, did not develop seeds, while those that were not inoculated and those manured with nitrogen all bloomed and some few produced seeds in spite of their less luxuriant growth. This is stated as being a further indication that the action of the bacteria in leguminous plants encourages the vegetable growth at the cost of the development

of the reproductive organs; and it is suggested that this may in many cases prove an important practical consideration, as in the case of leguminous plants grown for fodder.

Some studies were made with reference to the morphology and nature of the root tubercles of the pea. The form and character of the filaments and bacteroids were carefully studied, and subsequently the tubercles produced on the pea under the influence of lupine extracts were observed. In the latter case the filaments were just as numerous and of the same general appearance as where the inoculation was with bacteria from pea tubercles, and the bacteroids were of the form found to be characteristic for the pea. This leads the authors to assert that the formation of the filaments and the general appearance of the bacteroids is dependent, not upon the kind of bacteria causing them, but upon the plant on which they are formed. This would seem to support Frank's theory, that both the filaments and the bacteroids are products of the cell plasm of the plant rather than of the bacteria themselves. However, forms believed to be bacteroids were found, often in large numbers, in the pure cultures and especially in those of lupine bacteria. This leads the authors to agree with Prazmowski that the bacteroids proceed from the bacteria themselves. They also express the belief that the nitrogen which the plant gets by this symbiosis is very largely a product of the metabolism of the bacteria, and that only a relatively small portion is derived through the absorption by the plant of the bacteria or bacteroids.

Vegetation experiments in boxes, F. Wohltmann and H. Scheffler (*Ber. aus d. physiol. Laboratorium u. d. Versuchsanstalt d. landw. Inst. d. Univ. Halle, 7 (1887); ibid., 8 (1891)*).—In the year 1885, Dr. Wohltmann began an extensive system of experiments in the experimental garden of the Agricultural Institute of the University of Halle, the purpose of which, as expressed in the title of his descriptive memoir, was to furnish "a contribution to the testing and improvement of the methods of exact experiment for the solution of current questions regarding the treatment of soils and cultivation of plants." Certain improvements upon Wagner's method of pot experiments as then developed were attempted by Wohltmann, and the opportunity was utilized for studying the growth of plants under the action of different fertilizers in a soil of a type very common in north Germany.

Wagner uses zinc cylinders, which are placed upon small cars so as to be conveniently handled and run under a cover when necessary for protection from storm or frost. To these cylinders Wohltmann makes several objections, of which the chief are in substance that since they are exposed on all sides to air and the sun's rays, the soil in them must undergo greater changes in temperature than in its natural situation; that the surface area is not large enough; that the depth is not sufficient for normal root development; and that the water supply and drainage are not normal. To provide the desired surface area, depth, and bulk

of soil, Wohltmann used zinc boxes, 85 cm. long and about 47 cm. wide (surface area 0.4 square meter) and 1 meter deep, *i. e.* about 34 inches long, 18½ wide, and 39 deep. The zinc was protected by asphalt varnish. To secure natural temperature, the boxes were sunk in the earth so as to have the soil within and without at the same level, and plants of the same species as those grown in the boxes were also grown in the soil between them. To facilitate proper regulation of water supply from below, drainage, and collection of drainage water, a perforated zinc tube, which was coated inside and outside with asphalt varnish, was laid on the bottom of each box and covered by semicylindrical drain tile. This tube passed through the end of the box at the bottom. To the end of the tube outside the box was connected a perpendicular glass tube so that water could be introduced at will and the height of the water table maintained at any desired level and conveniently observed.

A faucet was attached to the tube at a height of 20 cm. from the bottom. By this the drainage water was collected in a graduated 5-liter flask which stood underneath. The boxes were placed on a brick foundation. To provide for getting at the drainage tubes, passages a little more than 1 meter deep were made between the rows of boxes. The boxes were filled to a depth of 23 cm. from the bottom with pure quartz sand (which thus served as subsoil), and then to within 2 cm. of the top with the soil selected for the experiment. This was a sandy loam which contained but little humus and had been cropped for 3 years without manure. The soil was taken from the field to a depth of 33 cm., *i. e.* so as to include only surface soil, and was sifted and thoroughly mixed, so that it should be of uniform character for all the boxes. Investigations were made of fineness (elutriation), water-holding capacity, and chemical composition of both sand and soil.

Seven kinds of plants were grown, barley, wheat, oats, yellow lupines, blue lupines, peas, and beans. The seed was chosen with a view to its special fitness for the experiment and was tested in germination trials. The individual seeds were carefully selected, so as to have those of each plant as nearly alike as practicable in appearance, weight, and specific gravity. They were sown at distances apart corresponding to those in the best field practice.

The fertilizing materials were furnished in nitrate of soda, sulphate of potash, and plain superphosphate, each singly and all three together. To compare the effects of phosphoric acid in different combinations, "double superphosphate" was used in some of the earlier trials, but replaced by a mixture of plain superphosphate and potash salt after trials of two successive seasons had shown that phosphoric acid had but little effect. The quantities of fertilizers were made equivalent to the largest ordinarily employed, so as to insure generous supply.

The boxes containing plants were arranged in 7 rows running east and west and 11 rows running north and south. In addition to these

were 2 in which the soil remained fallow, making the total number 79. Of the 7 east and west rows, 1 was devoted to each of the seven kinds of plants. Of 11 north and south rows, 2 were unmanured, 2 received the mixture of the three fertilizing materials, 2 nitrate of soda, 2 sulphate of potash, 2 plain superphosphate, and 1 double superphosphate in 1885 and 1886 and plain superphosphate with sulphate of potash in 1887. Each test with each plant and fertilizer was thus made in duplicate, except in the single row last mentioned. The same kind of plant was grown in the same box year after year and with the same fertilizer, except in the case of the single row referred to.

To facilitate proper distribution of the pollen of the lupines, a hive of bees was kept near the plants. Instead of a cover of wire netting, which is sometimes used to prevent the ravages of sparrows when the seeds are maturing, a *Geier* (a kind of small hawk) was kept confined by a chain close by, and for a short time strings carrying strips of colored paper were stretched over the plants. No trouble from birds was experienced, though the *Geier* have in other instances not sufficed to frighten the sparrows away.

The observations on the plants harvested, which are reported in detail, include weight of whole crop and of seed and straw (including chaff) separately; the number, length, and weight of stems; weight of leaves and of ears or pods from which the seeds had been removed; number and weight of ears or pods with seed, and weight of seed per ear or pod, large and small; averages per plant for total weight, and weights of seeds, ears or pods, leaves, and stem separately; and calculated yield of seed, straw, and whole crop per hectare. The weights as given refer to air-dry material. Determinations were made of the percentages of nitrogen, ash, potassium oxide, and phosphorus pentoxide in the whole produce and in the seed and straw separately, and from these are made calculations of the amounts contained in the produce per experiment and per hectare. No determinations were made of the amounts of moisture, so that the figures do not show the actual composition of the plants, *i. e.* of water-free substance. The samples analyzed were taken from the boxes of only 1 of the 2 duplicate rows of plants which received like treatment. Hence while the data for quantity of air-dry material represent averages of two duplicate trials, those for chemical composition represent only one of the trials.

Barometric pressure, rainfall as shown by rain gauge, temperature of air, and temperature of soil at the surface and at different depths of the soil between the boxes, as indicated by thermometers, were observed and recorded during the growing period from April to September. Determinations of evaporation of water by the method of H. Wild of St. Petersburg were attempted, but found unsatisfactory and given up.

For study of the water supplied to the soil, determinations were made of the amount of water, (1) in the soil at the beginning as found by moisture determinations in a sample; (2) supplied by rain as measured

by the rain gauge; (3) supplied artificially, either by surface watering or by watering from below, *i. e.* pouring water into the glass tube; (4) removed as drainage water through the tube. The height of the water table (ground water), which was occasionally raised by pouring water into the tube, was also noted. By adding the amounts supplied by rain and artificial watering and subtracting from this sum the amount removed by drainage, allowance being made for change in the height of the water table, an estimate was made of the amount which escaped by evaporation from the surface of the soil and by transpiration through the plant. To make the estimates accurate, determinations of the moisture at the end as well as at the beginning of the experimental period would have been necessary, but such determinations were not convenient, and it was thought that the error would not be large enough to rob the estimate of value as a general indication of the amounts of water which escape from plant and soil under similar conditions in ordinary field culture.

In a number of the specimens of drainage water determinations were made of the proportions of nitrogen, phosphoric acid, and potash.

Dr. Wohltmann began the experiments in 1885, repeated them in 1886, and was then compelled by illness and absence from Germany to leave them. They were continued in 1887 by Dr. H. Scheffler. But the labor involved was large, and, what was still more serious, leaks appeared in a number of the boxes, thus interfering with the studies of moisture supply and drainage, and the investigation was therefore given up. The boxes of soil have since been used for the study of diseases of plants, to which the experimental work of the institute is especially devoted and for which these arrangements are well adapted. The experiments of 1885 and 1886 were reported by Dr. Wohltmann in 1887. Those of 1887, with final conclusions, have just been published. The whole memoir, which fills some 240 quarto pages of text, is supplemented by numerous and extensive tables of numerical details.

Results of the experiments.—The experiments with beans and lupines were unsuccessful, partly because of diseases for which no adequate remedy was found and partly for reasons which could not be explained. The lupines developed very unequally in the duplicate boxes. Dr. Wohltmann attributes this to individual differences in the plants and thinks that the lupine can hardly be regarded as a suitable plant for such experiments as these (in which relatively few plants are used for each trial) until means shall have been found, by studies of the seeds or otherwise, to secure like plants for all the trials of the experiments. In the compilation of average results the beans and lupines were left out of account.

The experiments with barley, oats, wheat, and peas were in the main successful, though in a few instances the plants were injured by diseases. In several cases, in which the germinating seeds or very young plants were thus affected, second sowing was resorted to. The cases in

which the injury was deemed sufficient to impair the validity of the results were very few.

The total yields in the successful trials, especially where fertilizers were used, were for the most part larger than are usually obtained in field practice, even with the best treatment—a circumstance easily explained by the natural richness of the soil, the abundant water supply and manuring, the careful selection of seed, and thorough cultivation.

Since the results are of less consequence for the purposes of this abstract than the method, they may be recapitulated very briefly:

(1) The effect of the phosphates and potash salts upon the total yield, the proportions of the different parts, and the chemical composition of the plants, was not especially marked, except that in the experiments with oats, especially the first season, the total yield was somewhat larger with these fertilizers than without them. It was evident that the soil, although it had been cropped for several years without manure, contained a considerable supply of available phosphoric acid and potash.*

(2) With nitrate of soda, however, the total yield of the barley, oats, and wheat was considerably increased, though the ratio of grain to stalk was not materially affected. The total yield of peas, on the other hand, was not notably increased. while the ratio of the seed to the total weight of the plant was less and the proportion of stem and leaf was greater with the nitrate of soda than without it. The soil supply of nitrogen evidently did not suffice for full growth of the cereals and they responded to the nitrogen of the fertilizer. The peas, however, refused as usual to respond to nitrogen, that is to say, the total product was not increased, though there was a tendency to increase of stem and leaf and decrease of seed. The principal effect of the fertilizer seemed to be in causing development of the vegetative rather than the reproductive organs.

(3) The increase of yield of the cereals with nitrate of soda was most marked with the barley and least with the wheat, as appears from the following tabular statement:

Yield (weight of produce) with nitrate of soda, the yield without manure being taken as 100. Average of three seasons.

Cereal.	Grain	Straw.	Whole plant.
Wheat	138.9	137.3	138.1
Oats	153.1	140.2	144.3
Barley	163.0	157.3	159.8

* The necessity of avoiding excess of available plant food in soils in which experiments on the action of fertilizers are to be made, is here illustrated. Even soils supposed to be well "worn out" often have large supplies of the very substances the action of which in the fertilizers is to be tested. In some of the German stations a regular system is adopted for preparing soils for such experiments by growing plants upon them without manure for several successive seasons.

The percentages of protein were in general decidedly larger in the plants which had nitrate of soda than in those which were unmanured. Exceptions to this rule, however, were found with the cereals in 1886, which season was wet, while in 1885 and 1887 it was relatively dry. The average daily rainfall during the growing months of May, June, and July was, in 1885, 1.86 mm; in 1886, 2.66 mm; in 1887, 1.73 mm. The following figures give the differences found by subtracting the percentages of protein in the unmanured plants from those in the corresponding plants treated with nitrate of soda. It is to be remembered, however, that the analyses were made of single and not of duplicate samples, and that the figures in this table, as in the one just preceding, refer to the air-dry substance. It is not impossible that determinations of water and calculations of weight and composition of water-free substance would have made some changes in the relative proportions, though it seems hardly probable that the tenor of the results would have been materially altered.

Increase (+) or decrease (—) in percentages of protein in produce with nitrate of soda as compared with no manure.

Cereal.	1855. Relatively dry		1886. Relatively wet.		1887. Relatively dry.		Average of three seasons.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Barley	+2.6	+0.6	+0.2	−0.1	+2.6	+0.9	+1.8	+0.5
Wheat	+2.6	+0.8	−0.4	+0.7	+3.2	+1.9	+1.8	+1.1
Oats	+2.1	+0.7	−0.9	−0.3	+1.5	+0.4	+0.9	+0.3
Peas	+2.8	+1.7	+2.4	+0.8	+2.8	+0.4	+2.7	+1.0

(4) The percentage of ash was apparently not affected by the phosphate and potash salt in any of the plants nor by the nitrogen in the peas, but in the cereals it was lower with the nitrate of soda than without it.

(5) As regards the relative development of the different organs, the water supply seemed to have more influence than the fertilizers. When the rainfall was large the stems and leaves were developed at the expense of the seed.

(6) The amount of water which escaped by evaporation from the soil and by transpiration through the plants during the growing season, varied greatly with the seasons. From the observed results Dr. Wohltmann has made computations of what he regards as normal quantities in liters per plant and per kilogram of dry substance. These, with the estimated amounts per hectare in cubic meters for each of the three seasons, are given in tabular form herewith. The quantities are for the periods of vegetation of a little over 3 months.

Amounts of water evaporated from soil and plant during the growing season.

	Barley.	Wheat.	Oats.	Peas.	Fallow.
Estimated normal amounts—	*Liters.*	*Liters.*	*Liters.*	*Liters.*	*Liters.*
Per plant	2.0	1.6	2.7	5.6	....
Per kilogram of air-dry plant	350	400	350	300	... ...
Estimated amount per hectare—	*Cubic meters.*	*Cubic meters.*	*Cubic meters.*	*Cubic meters.*	*Cubic meters.*
Season of 1885	2.463	2.702	2.666	2.245	2.075
Season of 1886	3.475	3.625	3.625	3.575	2.800
Season of 1887	2.900	2.975	3.050	2.000	2.775

The experimental method.—Despite the mishaps in these particular experiments, Wohltmann regards the method as having proved itself fitted for its purpose.

(1) The chief difficulty was caused by leaks. The sides of the boxes next to the passageways being subject to outward pressure from the soil within and not protected by corresponding lateral outside pressure, bulged out and pressed against the upright glass tubes. The joints of the latter were thus loosened and in some cases the tubes were broken. This and defective stoppers were the causes of the leaks. A simple arrangement is proposed for remedying these difficulties and providing at the same time for drawing off the drainage water at the bottom instead of at a point 20 cm. above the bottom, as was done in these experiments. This would also allow better regulation of the height of the water table.

(2) One essential test of the value of the method is the agreement of duplicate trials as shown by the amount of produce. In each of the three seasons' experiments four kinds of plants—barley, wheat, oats, and peas (the trials with beans and lupines were left out of account in the comparison because of failure of a number of plants, as above stated)—were grown, each in 5 duplicate series with different fertilizers or unmanured. This made for each year 40 single or 20 duplicate trials. In these 60 cases there were 3, all with peas the second season, in which the plants of one of the duplicates were so defective as to make the results unsatisfactory. The agreement of the duplicates in the other 57 cases was computed by taking the larger yield of the 2 duplicates in each case at 100 and the smaller at the corresponding number, and calling the difference between these two numbers the difference of duplicates in per cent. This percentage difference of duplicate trials averaged in 1885, 3.4; in 1886, the moist season, 5.7; in 1887, 3.8; and in all the 57 cases of the three seasons together, 4.3 per cent. It exceeded 5 per cent in 16 cases, of which 8 were in 1886, and exceeded 10 per cent in 7 cases, of which 5 were in 1886. The differences of over 5 per cent did not occur in the same pairs of boxes in 2 different years in more than 2 cases, and in only 1 of these did the differences appear in 2 successive years.

It was thus clear that these differences in yield of duplicates were not due to differences in soil or any other constant factor. The inference

is that they are to be ascribed to differences in the productive energy of the individual plants. Here, in Wohltmann's judgment, lies the chief difficulty in the way of exact experimenting with plants on a small scale. The individuality of the plants is the one factor which is beyond control. The only way to avoid its disturbing influence is to increase the number of plants and take the average results. It is to be noted, however, that the variations from the mean of the duplicates, which would be only about one half the above percentages, average only 2.2 per cent, that they exceed 5 per cent in only four cases, and that they reach only 7.7 in the worst case of all. This range of probable error is not regarded by the author as sufficient to seriously affect the value of experiments for ordinary purposes, and hence in this respect the method is regarded by him as satisfactory. Boxes of the size of those used by Wohltmann, with 0.4-meter area, have the advantage over Wagner's smaller cylinders that they hold more plants, and thus decrease the error due to difference of individuality of plants.

As a means of avoiding the difficulty of disagreement of duplicates, Wohltmann urges the importance of several parallel trials—triplicates at least, and more if convenient. Another advantage of the larger number is that if the plants in one box are injured the experiment is not spoiled.

(3) Wohltmann claims as further advantages of the boxes sunk in the earth as compared with Wagner's small cylinders above the surface of the soil, that the conditions are more nearly normal; the observations of drainage water are valuable; and the time, labor, care, and confinement required of the experimenter are not half as large. [The reason for the last-named difference is that Wagner's pots have to be weighed very often, in the time of rapid growth of the plants once or even twice a day, in order to determine the amount of water which must be given to keep the soil properly moist, and that the attendant must be constantly on hand to put the plants under cover when a storm is imminent, while in Wohltmann's boxes the water supply can be regulated by keeping the water table at the desired level, and no constant attention is otherwise required.] On the other hand, Wagner's plan of keeping the pots on small platform cars beside a glass house, into which they are easily run, gives very valuable protection against frost and storms, *e. g.*, severe rain or hail, which may sometimes ruin a whole season's work.

(4) While Wohltmann recognizes the incompleteness of our present methods for physical and chemical studies of the soil, he still urges their great importance for investigations of this class.

In conclusion, the author calls attention to the usefulness of the boxes described by him for educational purposes. They offer a very convenient means for demonstration of experiments, and might be advantageously used by agricultural schools, especially those which have not adequate field and garden area.—[W. O. A.]

Plat and box experiments at the Dresden Experiment Station for Plant Culture.—In connection with the preceding article a description of the arrangements made for vegetation experiments at the station for agricultural and horticultural plant culture in Dresden, Saxony, will be of interest as an illustration of the way in which a new station in Germany, with the fruits of large experience but only limited amounts of money at its disposal, utilizes the teachings of that experience to secure the best results.

The station was organized April 1, 1890, at the solicitation and in the special interest of practical farmers and gardeners, and is just now (autumn, 1891) completing its arrangements for experimental work. Its annual income for current expenses, exclusive of land, buildings, and outfit, is about $3,000. Its energy is to be devoted to inquiry in vegetable production, and as the neighboring station at Tharand, which has been under the direction of Professor Nobbe for nearly a quarter of a century, is engaged in more abstract researches in vegetable physiology by the methods of the laboratory and the greenhouse, the Dresden Station will give itself to investigations on the growth of plants in natural soil, thus imitating more closely the conditions of practical culture. The agricultural division of the station, which is under the charge of Dr. B. Steglich, proposes experiments with different crops, on several kinds of soil, for the study of the merits of different varieties of plants, the effects of fertilizers, and the gains and losses of plant food by the soil. It recognizes the value of field experiments, but wisely arranged to have them made in different places in Saxony by intelligent farmers under its direction. The somewhat limited area of land at the station is thus left free for experiments on a smaller and more accurate scale, for which purpose it is ample. The station is being well equipped with buildings, greenhouses, and laboratories, and the agricultural division has 2 hectares (about 5 acres) of land devoted to various experiments with plants. The special interest for our present purpose is in the arrangements for plat and box experiments.

It was felt desirable to prosecute certain experiments upon the growth of plants on the kinds of soil most common in Saxony, and to make them as accurate as possible. For this purpose the upper stratum of soil of a certain area of the station land is being removed and replaced by soils of the desired kinds. Soils of five typical classes have been chosen for the purpose. They are designated by the terms, heavy clayey, loamy, calcareous, light sandy, and humous. For these different soils separate lots are provided. Each lot is divided into ten long, narrow plats, each plat being 25 meters long and 4 meters wide and containing 10 ares. The plats are separated by strips 1 meter wide and around the border of the lot is a path of the same width, so that the whole lot is 51 meters long and 27 meters wide, with the plats running across it from side to side. The clayey, loamy, and sandy soils are obtained near

the station, so that the cost of transportation is small. The others had to be brought from a distance. The surface soil is used in each case. In preparing each lot for experiment the original soil and subsoil are removed to the depth of 1 meter. At this depth the natural subsoil is sandy and pervious, and apparently uniform over the whole experimental area, so that it seems reasonably certain that the drainage and water supply from below will be alike throughout. The space thus excavated is then filled with the imported soils. These are very thoroughly mixed, shovelful by shovelful, so that each lot is uniform in physical and chemical characters. Two lots are to be devoted to the loam, on account of the prevalence of soils of this class in Saxony and its consequent importance for experiments. For the calcareous and humous soils, which have to be brought from quite a distance, one half a lot or five plats for each are used. To each of the other kinds of soil one lot is to be devoted.

By this means it is hoped to secure uniform conditions of temperature, moisture, and chemical and physical character of soil for all the plats of each type of soil.

To protect plants at the time of the ripening of the seeds from the depredations of sparrows, which are very numerous in the locality, it is proposed to stretch wire netting over the lots. The same arrangement is planned for the box experiments to be described beyond. An attempt to frighten the birds away by a bird of prey confined by a chain near by, did not prove successful.

Such an arrangement as this is fitted for tests of fertilizers, methods of planting or tillage, or varieties of plants. The first experiments here are to be tests of varieties of wheat, which is now a very important subject for farming in Saxony.

But plat experiments, however carefully planned, do not entirely suffice. Even if the conditions of soil, subsoil, temperature, and rainfall are uniform there is no way of measuring or controlling the supply of moisture. Other important questions, such as the gain and loss of plant food with different plants and under different methods of treatment, can not be accurately studied in this way. To facilitate such investigations the station had recourse to box experiments.

In the language of Dr. Steglich, who has supplied the data for this account of the plans for experiments at Dresden,—

For tests which require scientifically exact installation and the control of certain conditions of growth, a system of vegetation boxes is provided. These are filled with the soil which is to be experimented with and placed in the ground in rows. Each row represents a series of experimental trials. The soil between and around the boxes will bear the same kinds of plants as that within them, so as to secure uniform growth. Thus each box represents an entirely isolated portion of the whole experimental area. * * * In the present state of experimental inquiry an arrangement of this kind, especially in the light of what has been done by Wolff and Wagner, is really indispensable wherever the purely scientific results of laboratory investigation are to be applied to practice, or wherever exact experiments are to be made.

In planning the boxes for experiments, Dr. Steglich studied carefully the plans which had been followed by Wolff, Wagner, Hanamann, and others, and endeavored to improve upon them. In order to make the area and depth of soil sufficient for normal growth of a considerable number of plants, it was decided to have the boxes 1 meter long, wide, and deep (inside measure). It was essential that they should be very strong and durable and not liable to be cracked by frost or disintegrated by the gases and liquids of the soil and the roots of the plants; and, finally, they must be water-tight. Zinc it was feared would hardly fulfill these conditions. Iron would rust unless it was covered by some enamel, and this was found to be hardly feasible for vessels of the desired size. Glazed earthenware would be excellent, but the information from manufacturers as to the feasibility of making such large vessels was such as to discourage the attempt to get them. A preliminary trial was made with earthenware tiles, but they were unsatisfactory on account of the number of joints to be filled. Another trial was made with glass plates set in cement. The boxes thus constructed and placed in the ground stood the severe winter of 1890–91 very well, and these materials were finally selected. The boxes as made are really of cement lined with glass. The plates of glass 1.3 cm. thick were put together in a cubical box, which serves as a mold, and the cement was cast around them. The thickness of the cement is about 8.7 cm., so that cement and glass together make the whole thickness 10 cm. The joints of the glass are carefully covered with red lead putty to insure more perfect closure. To provide for outflow of drainage water and its collection for measurement and analysis, as well as for inflow of water for moistening the soil from below, an opening is made through both cement and glass close to the bottom on one side, which may be called the front of the box. Into this opening a glass drainage tube is inserted horizontally. Inside, on the bottom of the box, a perforated semicircular drain tile is laid from the opening to the opposite side. The box is sunk in the ground with its bottom resting upon a foundation of concrete 20 cm. thick, and its top level with the surface of the surrounding soil. In filling the boxes a layer of gravel is laid upon the bottom, and on this is placed a layer of sand which reaches to a height of 20 or 25 cm. On the sand, which serves as a pervious subsoil, rests the soil which reaches to the top of the box. The soil selected for the experiment is carefully sifted and thoroughly mixed so that the portions in the different boxes shall be as similar in character as possible.

Twenty boxes are placed in four equal rows, with passages between the first and second, and the third and fourth rows. These passages are sunk in the ground to a depth of 1.8 to 1.9 meters. They are 1.5 meters wide and are faced on the sides and ends by a brick wall. Each of the two passages has a fall of 10 cm., allowing water to flow to the lower end, where it runs through apertures in the wall into a bed of gravel outside especially provided to receive it. The two passages open into

a third of like depth and 1 meter wide, into which a stairway descends from the level of the ground outside. The passages are closed at the top by tarred planks which are covered by a layer of sand. The boxes of each row are separated from the passage wall and from each other by spaces 0.5 meter wide. The rows of boxes between the two passages are separated by a space 1.2 meters wide. These spaces are filled with soil. Thus each box is surrounded on all four sides by earth. The glass drainage tube which comes from the bottom of the front side of the box is covered with an iron tube and projects through the outer soil and the brick wall of the passage into the passage itself. Here it is joined by well-devised rubber and brass connections to a perpendicular glass tube, which may be called a supply tube, and through which water can be poured for watering the soil from the bottom. A small glass tube, projecting upward into this supply tube from the bottom, serves to remove the drainage water. It can be raised or lowered at will, so as to have the upper end at the level at which the water table in the box is to be maintained. If by reason of heavy rain the water of the soil in the box is increased so that the water table would rise above this level, the excess runs off as drainage water. If on the other hand the soil gets dry and the level of the water table is lowered, it is easily raised by either pouring water on the surface of the soil or by introducing it through the supply tube. The height of the water table can be seen at any time in the supply tube, which serves as a gauge.

The boxes with the passages and stairway are surrounded by a strip of lawn and inclosed by a wire fence, the whole inclosure being some 18 meters long and 14 meters wide.

The cost of each of the boxes was, for glass $15, setting in cement and transport to the station $13.25, drainage and supply tubes and setting $2.50, drain tiles $1, total $31.75; or for the 20 boxes, $635. To this must be added the cost of digging, setting the boxes, masonry, inclosing, etc.—about $250. Other expenses will probably bring the whole cost to not far from $1,000 for the completed plant for box experiments.

Close at hand are appliances for meteorological observations, including rain gauge, barometer, psychrometers, and air and soil thermometers. The soil thermometers are placed on the surface of the soil and at depths of 0.02, 0.05, 0.15, 0.25, 0.50, and 1 meter. The underground thermometers are inserted horizontally into the soil through a wall of a passage 1.5 meters deep, specially sunk into the ground for the purpose. The bulbs reach in to a horizontal depth of 0.5 meter, except in the case of the two lowest, which extend to lateral depths of 0.75 and 1.25 meters, respectively. The scales reach outside, so that the tridaily readings can be made with the greatest convenience.

The station at Tharand, with which the one at Dresden is closely affiliated, is engaged in the study of the action of bacteria in the assimilation of the nitrogen of the air by plants. In the division of

labor between the two, the Dresden Station has more to do with the application of the results of abstract inquiry. Accordingly for some time to come the box experiments are to be devoted to the study of the accumulation of nitrogen in soil in which leguminous plants (in this case lupines) are grown. The purpose is to make an accurate practical test of the teachings of late experimental inquiry regarding the acquisition of atmospheric nitrogen by the aid of bacteria. Two kinds of soil are to be used, one sandy, the other a loam, each in ten boxes. As the purpose is to investigate as thoroughly as may be the changes in nitrogen content of the soil in the presence of the plants, it is desirable to use soil in which no plants have grown. Accordingly in taking the samples for experiment the surface soil is removed as far down as the roots of the plants upon it extend and the soil below is used. For trials with each soil two rows of boxes, with five in each row, will be used. One row will be treated with extract from a soil in which lupines have grown, while the other will be left without this treatment, in order to observe the effects of inoculation, which has been lately observed to produce such remarkable effects upon the growth of legumes and the acquisition of nitrogen. Analyses of the soil will be made at the outset and from time to time during the progress of the research, and the amounts of water supplied and removed, the composition of the drainage water, and the amounts and composition of the produce will be determined. The data thus obtained, together with the meteorological and other observations made in connection with the experiments, will give the desired statistics of the gain and loss of nitrogen. If the investigation meets with the success which is hoped for, it will throw light upon one of the most important problems in agricultural science.—[W. O. A.]

Concerning the fermentation of tobacco, E. Suchsland (*Ber. d. deut. bot. Ges., 9 (1891), pp. 79–81*).—This is a preliminary report of investigations made by the author under the personal direction of Professor Zopf. The author explains that a very important part in the curing of tobacco is its fermentation, which occurs during the process known as bulking. The cured tobacco is packed closely together in large piles, and after a longer or shorter time, depending upon the amount of moisture the tobacco contains, the mass heats, the tobacco is said to "sweat," and the aromatic and other compounds which contribute to the taste and odor of the leaf and give it tone, are formed. It was to study these changes and to discover if possible the organisms believed to be the cause of the fermentation that the author made the investigations here reported. The results of his work, which are only given in brief, he believes to be of considerable practical interest. Tobacco from Havana, St. Domingo, Kentucky, Brazil, Turkey, Greece, Russia, Alsace-Lorraine, and other parts of Europe was studied, and in all cases large quantities of bacteria were found on the fermenting material, although the number of forms was small—usually only two or

three on each sort of tobacco. When pure cultures of the bacteria peculiar to any single sort of tobacco were used for inoculating tobacco of another sort, they induced the same taste and aroma as they had in the tobacco from which they were derived. Positive results were secured in every such trial.

The author therefore believes that the process of fermentation is one of much greater importance in improving the quality of tobacco than has previously been conceded. Up to the present time the improvement of the quality has been sought particularly in the improvement of the method of culture, and in the introduction of the choicest varieties; but this has been only partially successful since the forms of bacteria inducing the most advantageous fermentation, were not imported with the seed. His results all go to show that tobacco of poorer quality may be very greatly improved in quality by inoculating with forms of bacteria common to the choicer sorts; and he claims that he has repeatedly so changed the quality of domestic tobacco by regulating the fermentation that competent judges were unable to recognize it. Further communications are promised as to the forms of bacteria.

Regarding the products which the separate forms of bacteria build, definite conclusions are not yet reached; but the author is inclined to believe that among other things a change of nicotine to nicotine-camphor takes place during the fermentation.

At what degree of acidity does cows' milk curdle on heating? W. T. Thorner (*Chem. Ztg.*, 15 (1891), p. 1108).—The method employed for determining the acidity of milk was as follows: Ten c. c. of the milk to be tested were diluted with 20 c. c. of water, a few drops of phenolphthalein added, and the solution titrated with deci-normal potash solution. The number of tenths of a c. c. of alkali required for neutralization was taken as the degree of acidity of the milk, each tenth of a c. c. representing one (empirical) degree. As indicated by this method, the degree of acidity of the market milk of the city of Osnaburg was found to range as follows: At time of purchase (3 to 4 hours after milking) 12°–16°, 6 hours later, 14°–25°, 24 hours later 17°–60°, and 48 hours after this 30°–100°. The more rapidly the milk was cooled after the milking and the cooler it was kept, the more slowly did the acidity develop, and the reverse (except where kept at a temperature above blood heat). In these tests sunlight and darkness seemed to have very little effect on the rapidity of souring.

To determine the degree of acidity at which milk would be coagulated by heating to boiling, the author made a large number of tests of milk kept from 2½ to 28 hours in a cellar in the sunlight and in the dark. The results all pointed to 23° as the lowest degree of acidity at which milk would curdle on heating. Assuming 20° to be the limit of acidity allowed, he suggests that milk could be rapidly and simply tested by adding 2 c. c. of deci-normal alkali, and a few drops of phenolphthalein to 10 c. c. of well-mixed milk diluted to 30 c. c. with water.

If a red color is produced, even though a weak one, the milk will not curdle on boiling.

Canadian experimental farms, Annual Report, 1890 (pp. 314) (*Report of Director, W. Saunders*, pp. 5–53).—A summary is given of the report of experiments in early and late seeding of barley, oats, and spring wheat, recorded in Bulletin No. 8 of the Central Experimental Farm (see Experiment Station Record, vol. II, p. 520). The distribution of seed of oats, barley, wheat, peas, and corn in 1890 is described, and reports from persons who experimented with the seeds are summarized. The total number of samples distributed was 12,353 to 5,896 applicants. Notes and tabulated data are given for tests of 16 varieties of oats on small plats and 25 on large field plats; of 11 two-rowed and 5 six-rowed varieties of barley on small and large plats; 15 varieties of spring wheat on small plats, 5 on large plats, and 9 planted in rows 2½ feet apart; 9 varieties of winter wheat; 4 of winter rye; 1 of spring rye; 5 of peas; 17 of turnips in one series and 22 in another; 21 of mangel-wurzels; 14 of sugar beets; 25 of carrots in one series and 24 in another; and 94 of potatoes. Twelve hundred and forty-five samples of seed of grain, grasses, clover, vegetables, etc., were tested at the Central Experimental Farm in 1889 and 1890. The results, as stated in a table, show a wide variation in the average vitality of different kinds of seed. There is an account of the results of the growth of two-rowed barley from seed imported by the Government of Canada, taken from Bulletin No. 9 of the Central Experimental Farm (see Experiment Station Record, vol. II, p. 520). Information regarding experimental work in forestry on the western plains of Canada is given in a paper by the Director, which was read at the meeting of the American Forestry Association at Quebec, in September, 1890. Accounts are given of visits made by the Director to the different branch experimental farms of Canada, and a financial statement for the several farms for the fiscal year ending June 30, 1890. The number of letters received during 1889 was 6,864; during 1890, 19,806; number of bulletins and reports sent out during 1889, 41,584; during 1890, 218,129. The mailing list of the Central Experimental Farm is 20,600, in addition to a special dairy list of 4,000.

Report of Agriculturist, J. W. Robertson (pp. 54–68, figs. 51).—This includes an illustrated description of the experimental dairy building and the piggery erected at the Central Experimental Farm. Accounts are given of the swine and cattle of different breeds kept at the farm, with details regarding the rations fed to them.

Report of Horticulturist, J. Craig (pp. 69–102).—Under the head of orchard fruits, notes are given on varieties of apples, pears, plums, cherries, and apricots grown at the Central Experimental Farm, with special references to Russian varieties of apples and pears; and also notes on varieties of grapes, strawberries, raspberries, blackberries, currants, and gooseberries; and on 22 varieties of cabbages, 7 of celery,

12 of sweet corn, 10 of lettuce, 14 of peas, 13 of radishes, and 7 of tomatoes. An account is given of the distribution of different varieties of seedling forest trees and also of tree seeds. Experiments with fungicides for apple scab (***Fusicladium dendriticum***) are briefly recorded, and tabulated data are given for an experiment with fungicides on apple leaves, with a view to ascertaining (1) the greatest strength in which the different fungicides can be applied without injury to the leaves; (2) the effect on leaves of the copper solutions with or without ammonia; and (3) the effect on the leaves of a fungicide combined with Paris green. The Wealthy variety was used in this experiment. Copper sulphate, used in the proportion of 8 ounces to 22 gallons of water with or without ammonia or Paris green, caused much injury to the leaves, while copper carbonate, 1½ or 3 ounces to 22 gallons of water, caused little injury.

Report of Chemist, F. T. Shutt (pp. 103–153).—This report includes popular discussions of the physical properties and chemical composition of soils, the value of mud, muck, peat, marl, gypsum, wool waste, gas lime, and lamb's quarters (***Chenopodium album***) for fertilizing purposes, and analyses of the same; analyses of foods and feeding stuffs, milk, apple tree leaves, well water, and foundation comb; a study of the effects of solutions of copper sulphate, iron sulphate, and "agricultural bluestone" on the vitality of seed wheat; and an article on spontaneous combustion.

Fodders (pp. 116–133).—A popular discussion is given on the constituents of feeding stuffs, coefficients of digestibility, and nutritive ratio of food ingredients; a description of different feeding stuffs; analyses of linseed meal, cotton-seed meal, germ meal, Golden Tankard mangel-wurzel, lamb's-quarters, silage, and of corn, redtop, June grass, timothy, and tall fescue at different stages of growth; the percentage of dry matter and of starch in 80 varieties of potatoes as calculated from the specific gravity by the use of Holdefleiss's tables; and analyses of 64 samples of sugar beets raised in different localities in Canada. The tests of the samples of sugar beets show that 60 per cent contain over 12 per cent of sugar, and 38 per cent over 13 per cent of sugar.

The averages as they stand indicate a very fair factory beet, and, all things being considered, compare well and favorably with those of other countries in which beet sugar is manufactured. Sufficient work has been done to indicate that both as regards yield per acre and richness in sugar, with a more careful cultivation, sugar beets may be raised in many parts of Ontario fully equal to those of Europe and the United States.

Remarks are also made on the culture of the sugar beet and on the value of the diffusion chips for feeding purposes.

Milk (pp. 133–140).—Analyses are given of 93 samples of milk of Jersey, Holstein, Ayrshire, Aberdeen, Angus, and Shorthorn cows during short periods, together with the rations fed.

Composition of apple tree leaves (pp. 141–146).—This is from an article on this subject read by the author at the Dominion Fruit Growers'

convention at Ottawa in February, 1890. The composition is given of the leaves of Duchess of Oldenburg, Tetofsky, Wealthy, Fameuse, and Northern Spy apple trees, collected May 25 and September 20, and from these analyses is calculated the amount of nitrogen, phosphoric acid, and potash contained in 1,000 pounds of fresh leaves from each variety. The averages of the 5 varieties at each gathering are given in the following table:

Analyses of apple tree leaves.

	In green leaves.		Nitrogen in organic matter.	In 100 parts of ash—						Fertilizing ingredients in 1,000 pounds of leaves.		
	Moisture.	Ash.		Phosphoric acid.	Potassium oxide.	Calcium oxide.	Magnesium oxide.	Ferric oxide.	Silica.	Nitrogen.	Phosphoric acid.	Potassium oxide.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct*	*Pr. ct.*	*Lbs.*	*Lb .*	*Lbs.*
Gathered May 25	72.36	2.33	2.94	10.47	10.82	17.40	9.77	1.49	1 07	7.42	2 15	2 52
Gathered September 20 ..	60.71	3.46	2.48	5.82	11.03	27.91	4.81	1.41	1.14	8.87	1.91	3.92

Effect of solutions of copper sulphate, iron sulphate, and "agricultural bluestone" on the vitality of seed wheat (pp. 146–148).—In this test Red Fife wheat, containing 97.5 per cent of seed capable of germinating, was used. The agricultural bluestone was found to consist of 69.3 per cent sulphate of iron and 30.7 per cent sulphate of copper. The solutions were prepared by dissolving 1 pound of the material in 8 gallons of water. In the first experiment seed was soaked in each of these solutions during 36 hours, and at the end of that time was sown in earth in the conservatory to determine its percentage of vitality; in the latter experiment the wheat was merely sprinkled with the different solutions, allowed to dry, and sown at once. The results lead the author to conclude that—

(1) A solution of sulphate of copper of the strength of 1 pound to 8 gallons of water has the effect of destroying a number of wheat germs, and that even when the sulphate of copper is present only to one third of this amount (as it is in the agricultural bluestone) the injurious action is still strongly marked.

(2) A solution of sulphate of iron of the same strength has eventually but little destroying action on the wheat seed, though at first the plants from seed so treated have their growth somewhat retarded.

(3) The length of time that the sulphate of copper is in contact with the seed determines, to a large extent, the amount of damage done to the vitality of the germ. If sprinkling be sufficient to destroy the smut spores the grain should not be left in contact with the solution longer than necessary, but dried and sown at once.

The results of tests made to determine the value of solutions of sulphate of iron, sulphate of copper, and agricultural bluestone used in the strength given above for preventing smut in wheat "seem to indicate that none of the solutions tried are efficacious in preventing the development of loose smut." Experiments on this subject are to be continued.

Foundation comb (pp. 150, 151).—Analyses are given of three samples of foundation comb sent to the station to be tested as to purity. In addition to the analyses, directions are given for detecting adulterations of honeycomb.

Report of Entomologist and Botanist, J. Fletcher (pp. 154–206, plates 9, figs. 7).—The entomological portion of the report contains original and compiled notes on the American frit fly (*Oscinis variabilis*), cabbage maggot (*Anthomyia brassicæ*), diamond-back moth (*Plutella cruciferarum*), Mediterranean flour moth (*Ephestia kühniella*), pea weevil (*Bruchus pisi*), strawberry weevil (*Anthonomus musculus*), and Vancouver Island oak looper (*Ellopia somniaria*). The differences in the effects of the attacks of the frit fly, Hessian fly (*Cecidomyia destructor*), and wheat stem maggot (*Meromyza americana*) are stated and the several stages of these insects are differentiated. Successful experiments were made with white hellebore as an insecticide for the cabbage maggot. A solution of 2 ounces of hellebore and 3 gallons of water was applied with a syringe around the roots of cabbage plants from which the surface soil had been removed by hand. Kerosene emulsion proved the most satisfactory remedy for the cabbage plutella. The treatment of the seed of peas with bisulphide of carbon is generally adopted by Canadian seedsmen. For the strawberry weevil it is suggested to try covering the beds after the formation of the flower buds with newspapers or strips of cloth held down at the edges with earth. These should be put on at the first appearance of the beetles and kept on until the flowers have expanded. The Vancouver Island oak loopers, which defoliate oaks in the vicinity of Victoria, appear in the larval stage about the middle of August, pupate near the end of that month, and begin to emerge as moths by September 20. In 1890 they appeared in very large numbers. The insect passes the winter in the egg state. The eggs may be destroyed by spraying the trunks of the trees in early spring with kerosene emulsion. The larvæ may be killed with the arsenites. *Ichneumon cestus*, *Pimpla* sp., and a Tachina fly were observed as parasites on the oak looper.

Under the head of botany are given brief notes on 72 species of grasses which are being tested at the Central Experimental Farm, and lists of a number of species of native and foreign grasses with which some experimental work is being done. The nine plates which illustrate this portion of the report are taken from the publications of this Department.

Report of Poultry Manager, A. G. Gilbert (pp. 207–229).—Accounts are given of the methods followed in the management of various breeds of hens at the Central Experimental Farm. An experiment in setting hens on nests placed on dry boards and on the damp earthen floor of a cellar showed no great difference in the results as regards the number of chickens hatched. Experiments in keeping fertilized and unfertilized eggs at temperatures varying from 46 to 84° F. indicated

that eggs of either kind would preserve a good condition and flavor for several weeks, even at the highest temperature tried. During two winters the effects have been observed of feeding warm mixtures of ground meal of various kinds, with or without the addition of ground meat and red pepper, to stimulate laying. The results indicate that—

(1) The stimulating and fattening foods which go to eggs in the Spanish family, such as Leghorns, Minorcas, and Andalusians, make the Asiatics, viz, Brahmas, Cochins, and Langshans, so fat as to lay soft-shell eggs or not to lay any at all.

(2) Plymouth Rocks and Wyandottes (breeds of American origin, and not to be properly classed with either of the foregoing) are to be treated as Asiatics in the matter of food.

(3) It is best when possible to keep the pullets of late hatch away from the two-year-old hens, for the reason that the latter are at their best for egg production, and the fattening food that is suitable for pullets is likely to make the hens too fat to lay. The importance of having pullets hatched as early as possible will thus be apparent.

The author recommends that young chickens should be fed bread soaked in milk and squeezed dry. At first this should be given every hour, but the number of daily rations should be decreased as the chickens grow older, and after 2 weeks wheat may be fed, sparingly at first.

Report of the Superintendent of Experimental Farm for the Maritime Provinces, W. M. Blair (pp. 230–238).—Tabulated data are given for tests of 21 varieties of wheat, 17 of oats, 13 of barley, 30 of corn, and 69 of potatoes.

Report of Superintendent of Experimental Farm for Manitoba, S. A. Bedford (pp. 239–269).—Tabulated data are given for tests of 32 varieties of wheat sown on upland prairie and 33 sown in a valley, 20 of oats on the upland and in a valley, 11 of barley on the upland and 11 in the valley, 7 of peas, 16 of turnips, 5 of carrots, 83 of potatoes, 32 of fodder corn, and 4 of millet. There are also brief accounts of experiments in sowing wheat and barley at different dates, and wheat, barley, and oats at different distances and in drills and broadcast. Tabulated notes are given for the varieties of apples, crab apples, cherries, pears, plums, gooseberries, currants, and the species of forest trees and shrubs planted at the farm. Experiments are being made in the keeping of bees.

Report of Superintendent of Experimental Farm for the Northwest Territories, A. Mackay (pp. 270–292).—Tabulated data are given for tests of 48 varieties of wheat, 32 of barley, 16 of oats, 5 of peas, and 25 of fodder corn. There are also notes on experiments with forage plants, grasses, flax, buckwheat, beans, turnips, mangel-wurzels, carrots, sugar beets, potatoes, and a number of other vegetables; with apples, crab apples, pears, plums, cherries, currants, raspberries, gooseberries, and strawberries; and with forest trees and shrubs. Brief statements are made regarding the pedigrees of the cattle in the station herd. Experiments with poultry and with bees are in progress.

Report of Superintendent of Experimental Farm for British Columbia, T. A. Sharpe (pp. 293–309).—This includes lists of varieties of apples, peaches, pears, quinces, apricots, nectarines, plums, cherries, figs, oranges, grapes, blackberries, currants, gooseberries, and strawberries under experiment; tabulated data for tests of 12 varieties of winter wheat, 14 of spring wheat, 2 of winter rye, 19 of barley, 13 of oats, 29 of corn, 20 of beans, and 31 of potatoes; and lists of the species of forest trees, shrubs, and vines planted at the farm. The number of eggs laid by each of several breeds of hens during 1890 is given in a table.

EXPERIMENT STATION NOTES.

ARIZONA STATION.—V. E. Stolbrand, C. E., has been appointed meteorologist and irrigation engineer, and E. L. Benton horticulturist.

COLORADO COLLEGE AND STATION.—W. J. Quick, B. S., formerly agriculturist of the station, has been appointed director.

NEW YORK STATE STATION.—S. A. Beach, B. S. A., has entered upon his duties as horticulturist to the station.

OKLAHOMA STATION.—A. C. Magruder, formerly of the West Virginia Station, has been elected agriculturist and horticulturist. The station farm has been surveyed and the erection of buildings will be begun without delay.

PENNSYLVANIA STATION.—The barn on the college farm was completely destroyed by fire November 4.

VERMONT COLLEGE AND STATION.—The facilities for instruction in agriculture and the mechanic arts have been increased. A new building has been erected for the mechanical and engineering departments, and thoroughly equipped with apparatus for instruction in mechanical, electrical, civil, and sanitary engineering. A dairy school, opening December 1, will be held for 4 weeks.

The station has purchased a new farm near its laboratory building, and has erected a dwelling house, barn, creamery, and greenhouse. The station is now well equiped for experiments in botany and dairying. Purchases of registered stock of the Jersey, Ayrshire, and Holstein breeds have been made.

WASHINGTON STATION.—It is expected that the working staff of this station will be organized so as to commence experimental work during the coming season.

BRAZIL.—The report for 1890 of the station at Campinas, of which A. B. U. Cavalcanti is director, has been received. It includes analyses of soils from the State of Sao Paulo, analyses of coffee and an article on the culture of coffee in Brazil, by F. W. Dafert, Ph. D., notes on alfalfa and other forage plants, with analyses of meteoric water, and record of meteorological observations.

HALLE, GERMANY.—*Versuchs-Station für Nematodenvertilgung* desires to be put on the mailing list of the stations, and especially to receive all publications on entomology and mycology. Its annual report will be sent in exchange. Address Dr. M. Hollrung, Wurchererstrasse 1, Halle, Germany.

WORLD'S COLUMBIAN EXPOSITION.—A committee appointed to prepare rules to govern the conduct of a test of dairy breeds of cattle, in connection with the Columbian Dairy School, has submitted its report. Two tests of breeds are provided for. One of these is to continue 4 months, "1 month of which shall be devoted to cheese making, and shall be carried on in connection with the Columbian Dairy School; the other shall be for 7 days, 30 days, and 60 days, and be under the charge of the same committee as the 4 months' test, but the milk may be handled by the breeders." In the 4 months' test two classes of awards are to be made, (1) "for the best dairy cows, considering all commercial products and the value of increase of flesh; (2) for cows, herds, and breeds on the basis of the amount of butter or cheese made during the 4 months." It is recommended that the testing committee consist of the superintendent of the dairy department as chairman, one member appointed by the World's Columbian Exposition, one by the Columbian Dairy Association, four by the Association of American Agricultural Colleges and Experiment Stations, and a representative for each of the breeds competing.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING NOVEMBER, 1891.

Preliminary Report of the Secretary of Agriculture, 1891.

DIVISION OF STATISTICS:

Report No 90 (new series), November, 1891.—Report on Yield of Crops per Acre; Freight Rates of Transportation Companies.

DIVISION OF BOTANY:

Bulletin No. 14.—Ilex Cassine. the Aboriginal North American Tea.

ENTOMOLOGICAL DIVISION:

Insect Life, vol. IV, Nos. 3 and 4, November, 1891.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 3, October, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

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CANEBRAKE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 12, October, 1891.—Grapes, Strawberries, and Raspberries.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, July, 1891.—Ringworm.

COLORADO AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, July, 1891.—Artesian Wells of Colorado.

AGRICULTURAL EXPERIMENT STATION OF FLORIDA:

Bulletin No. 14, July 1, 1891.—Annual Report.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 24, September, 1891.—Enzoötic Cerebritis or Staggers of Horses.

LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 11 (second series).—Report of the Sugarhouse and Laboratory for 1890.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 34, October, 1891.

EXPERIMENT STATION OF MICHIGAN AGRICULTURAL COLLEGE:

Bulletin No. 77, November, 1891.—Comparing the Yield of Old Meadows with those Recently Seeded.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, September, 1891—Glanders.

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 84, October 10, 1891.—Ground Bone and Miscellaneous Samples.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 32, October, 1891.—Tomatoes.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 80*b*, September 15, 1891.—Meteorological Summary for North Carolina, August, 1891.
Bulletin No. 80*d*, October 15, 1891.—Meteorological Summary for North Carolina, September, 1891.

OHIO AGRICULTURAL EXPERIMENT STATION:
Bulletin vol. IV, No. 6 (second series), October, 1891.—Experiments with Small Fruits in 1891; Diseases of the Raspberry and Blackberry.

OREGON EXPERIMENT STATION:
Bulletin No. 12.—Comparative Test of Strawberries for 1891; Meteorological Summary.
Bulletin No. 13.—Mineral and Mineral Water Analyses; Soils and Agricultural Survey.

THE PENNSYLVANIA STATE AGRICULTURAL COLLEGE EXPERIMENT STATION:
Bulletin No. 17, October, 1891.—The Value of Cotton-Seed Meal as Compared with Bran for the Production of Butter.

RHODE ISLAND STATE AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 12, August, 1891.—Analyses of Commercial Fertilizers Collected under the State Inspection, 1891.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 2 (new series), July, 1891.—Cotton Experiments with Varieties and with Fertilizers.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF WISCONSIN:
Bulletin No. 29, October, 1891.—Creaming Experiments.

DOMINION OF CANADA.

ONTARIO AGRICULTURAL COLLEGE EXPERIMENT STATION:
Bulletin No. 68, October 26, 1891.—Feeding Shorn and Unshorn Lambs in Winter.
Bulletin No. 69, November 2, 1891.—Fattening Lambs for the British Market.

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